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TRAFFIC ENGINEERING & CONTROL

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The only British monthly devoted exclusively to traffic engineering.

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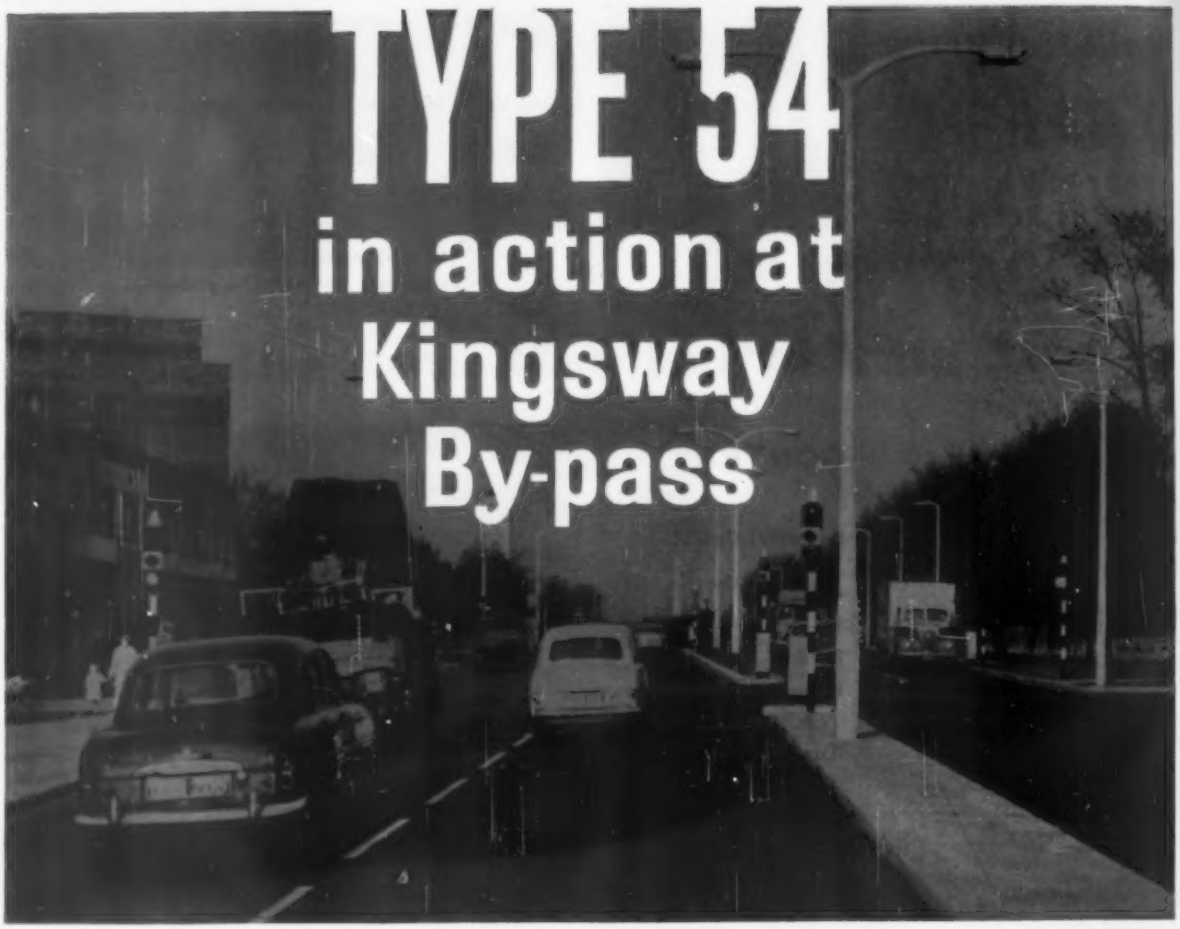
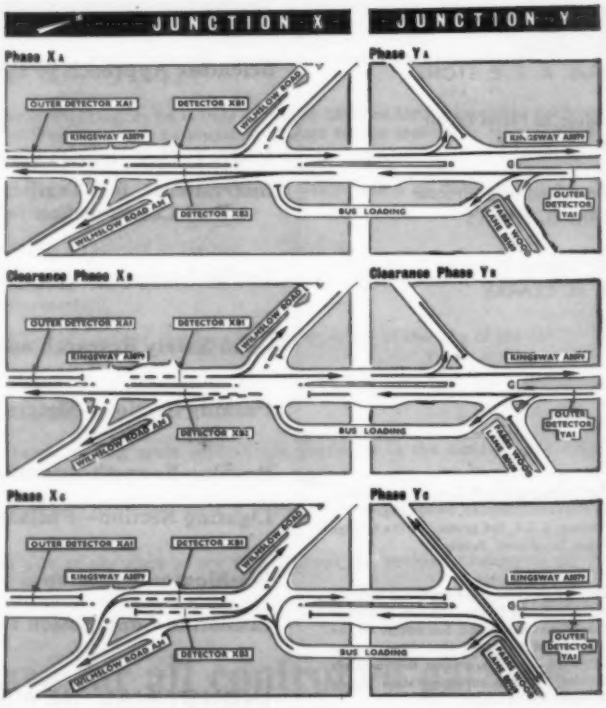
TYPE 54 in action at Kingsway By-pass



This advertisement, first of a series intended to feature the most interesting applications of Type 54 Controllers highlights the important Kingsway - Wilmslow road intersection and approaches, once one of the most congested junctions in the North of England but now a model of good traffic regulation with the factors of safety, speed and priority judiciously assessed, to the impartial benefit of every vehicle, by the Type 54 Controller.



Phase Xa and Phase Ya. *Kingsway traffic has right-of-way. Side road traffic and bus traffic from loading bay is held.*

Clearance Phase Xb. *Kingsway traffic is held at each side of the reservoir but traffic in the reservoir is allowed to flow out. Wilmslow traffic and bus traffic from loading bay is still held.*

Clearance Phase Yb. *Kingsway northbound traffic is allowed to flow. Kingsway southbound traffic is allowed to flow to Wilmslow Road to come under the control signals at that point. Parrs Wood Lane traffic is held.*

Phase Xc. *Kingsway traffic is still held at each side of the reservoir. Traffic from Wilmslow Road can now flow out and then filter left, or enter the reservoir to await the Kingsway phase Xa. Bus traffic from loading bay is released.*

Phase Yc. *Parrs Wood Lane traffic has right-of-way. Kingsway traffic is held.*

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Transport Policy and Traffic Engineering

ALTHOUGH traffic engineering is generally accepted as being the scientific application of engineering principles, the planning and design of roads and the control and regulation of traffic on them and when it comes to rest, it cannot be practiced or succeed in its objectives in isolation, that is if it ignores other forms of transport. Concerned as it is with the volume of traffic, it is as important to know in the long term what causes the traffic to grow or diminish, to be generated, as it is in the short term to know its immediate origin and destination. With this object in view, where traffic engineering is used to best effect, long-term traffic studies on land use are made. The Chicago Area Transportation Survey, for instance, was recently completed and the second volume has just been published, giving in detail predicted traffic volumes for the next 20 years, and its division as between different forms of transport. It is proposed to publish in an early issue of this Journal a summary of the results of this most comprehensive traffic study yet undertaken.

Traffic engineers in assessing future traffic volumes can neither ignore transport policy nor the state of affairs of other transport forms inasmuch as their development or contraction must react on the volumes of road traffic with which they are concerned.

The scheme for the reorganization of nationalized transport undertakings is a case in point since it is certain to influence the future pattern of transport and is of particular importance to all concerned with roads and traffic. It will influence the volume that uses the roads. One of the chief tasks of the traffic engineer is to plan, design and regulate roads and traffic to ensure that they yield their practical capacity. With the techniques at his disposal, he is able to predict future growth and, thanks largely to the work of the Road Research Laboratory, to assess their economic return. He has no vested interest in volumes, no selfish desire to attract into his bailiwick a greater share of the traffic offering, but merely to provide for those who find it more convenient or economic to use the particular form of transport with which he deals. In fact, since the resources at the disposal of all those concerned with road construction and improvement are limited, and quite inadequate to need, he probably has no wish to see his predictions proved wrong by a greater influx on to the roads than that expected; then saturation point may be reached and congestion and delay overtake his carefully designed plans.

Unfortunately it appears that the proposals for the railways may contribute to this result because the trend of present transport policy is to consider each transport form in isolation, to give each freedom to compete. The intent of former policies to achieve a measure of integration or co-ordination of transport, is abandoned. Its purpose was to provide the means and the attraction for traffic to use the form of transport most economic and suitable to it. The further disintegration of transport, which seems likely to result from the proposed segregation of the various undertakings of the British Transport Commission, and their separate operation under different administrations, only loosely linked through a National Transport Advisory Council, chaired by the Minister of Transport, may well throw more traffic upon the roads. The tendency will be further stimulated by the projected closure of uneconomic branch lines more speedily.

Already in this country a higher proportion of traffic goes by road than in any other Western European country, as has been revealed by the Annual Bulletin of Transport Statistics for Europe for 1959, recently published by the United Nations and which is the subject of an editorial note in 'Topics of the Month'. Up to the present, road traffic has, by and large, increased faster than predicted, even though the inadequacy of the roads may have acted as a slight deterrent and held back the growth of motorization which in some ways has been slower than in some European countries. If this is so, the case for even greater expenditure on the roads, already convincingly strong, is strengthened, but in the present state of the country's finances the outlook is not hopeful and larger expenditure than that already promised by the Minister cannot be expected. This makes it more important, not only that the most be obtained from existing roads, but also that long-term planning of future needs be undertaken now, so that if and when the roads programme can be stepped up and drawn over a longer period than is possible on the present basis of authorizations it can speedily be embarked upon. An article in later pages shows how this is being done in Sweden, where a 20-year programme has been planned, based on continuing traffic studies providing data far more extensive than is yet available in this country.

This is a technical and not a political journal. It is not concerned with politics but roads and traffic and in particular with the methods and techniques of traffic engineering and, to the extent that policies react upon these, they have to be taken into consideration. The present transport policy, by eschewing long-term planning, by failing to consider transport as a whole, and by preferring to consider each form separately can, in our view, only make more difficult the task of those concerned with making the roads adequate to traffic.

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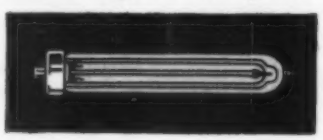

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Lighting installation at ADDINGTON ROAD, SELSDON. Stella Sodium Lamps and Control Gear used in this installation at 130 ft. spacing and 25 ft. 6 ins. mounting height. Photograph by kind permission of COULSDON & PURLEY U.D.C.

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Topics of the Month...

THAT the rate of growth in motorization during the last ten years has been less in Britain than in any other European country, except Ireland, is revealed by the Annual Bulletin of Transport Statistics for Europe, compiled by the Economic Commission for Europe, and recently published by the United Nations. For all countries for which figures were available, between 1950 and 1959 the compound rate of average increase for private cars was 13.8 per cent for all Europe, including Iron Curtain countries. Britain's figure was 8.9 per cent, France 14.2 per cent, Sweden 17.4 per cent and Western Germany 21.7 per cent. By 1959, Sweden had the largest motor vehicle fleet, with one private car to six inhabitants, against one to seven in France, one to eight in Britain and one to 12 in Germany. If all motor vehicles, including two wheelers, are included, the figures are one to four inhabitants in France, one to six in Britain and one to five in Sweden. Presented as the number of cars per 100 inhabitants, the figures are 16 in Sweden, 14.5 in France and 12.6 in Britain. For all countries, the rate of growth of private car fleets was on an average twice as fast as that of the national gross product but for Britain it was below this average. In fact, for all motor vehicles, but excluding two wheelers, the United Kingdom had the slowest growth of all, the increase being 1.6 times the national product, whereas in Sweden it increased 2.5 times. The relatively poor showing of Britain may not be unrelated to the equally unfavourable comparison provided by figures of expenditure on roads. For the few countries for which these are available, for 1959/1960 Western Germany spent $20.5 per inhabitant and $285 per vehicle, France (in 1956, the latest year for which figures are available) $12.5 per head and $115 per vehicle, and Britain $9.2 and $78 respectively. It is somewhat of a paradox that despite the lower figure for vehicles to inhabitants in Britain, and the lower expenditure on roads during this period, a higher percentage of goods are carried on British roads than on those of any other Western European country. Whereas in this country 57 per cent of total goods transport went by road in 1959, 42 per cent by rail and one per cent by inland waterways, in France only 29 per cent went by road, 60 per cent by rail and 11 per cent by waterways. For Western Germany the figures were 21 per cent by road, 47 per cent by rail and 21 per cent by waterways.

Expenditure on Roads in 1960

FIGURES of expenditure on roads during 1960, compiled by the International Road Federation from information provided by 161 countries and territories in the free world, usefully supplement the United Nation's figures for Europe. The total spent was $19.3 thousand million, an increase of three per cent over the 1959 figure of $18.6 thousand million. The United States had the highest expenditure at $11.8 thousand million, with Canada next at $1.35 thousand million. Western Germany came third, spending $1.2 thousand million, Japan fourth with $570 million and the United Kingdom fifth with a total of $520 million. This reflects the increased roads programme in Britain and would indicate that all other European countries are now topped by this country, except Germany.

In regard to motorways, however, Britain is still lagging further behind. Figures compiled from official sources by *Etudes Routières* give a total of 532 kilometres of new motorways opened for traffic during 1960. Italy accounted for just over half of the total, adding 268 kilometres to her motorways network. Germany opened 107 kilometres, whilst Great Britain came next with 63 kilometres, which comprised the Lancaster By-Pass, the Ross Spur and the Maidstone By-Pass. France's total was 41 kilometres, Belgium's 28 kilometres and Austria and the Netherlands 12 kilometres each. It is interesting to note that Italy's road construction was, to a large extent, privately financed, which inevitably results in the toll system. In view of the extension of the toll system to several European countries, and the intention to impose tolls for major bridges and tunnels here, it is proposed to publish an early article on operation of the toll system in the United States.

Easing London's Traffic

THAT the London Traffic Management Unit, under the direction of Dr. George Charlesworth, is making progress in its drive towards the reduction of congestion and easing of traffic flow is evidenced by the number of proposals being put forward and planned to come into operation later this year. These range from one-way systems in the Tottenham Court Road and Gower Street area, to elimination of right-hand turns at Victoria Gate, Hyde Park, and to the establishment of a peak-hour clearway from Knightsbridge to the Chiswick flyover. In regard to the latter, between 8 a.m. and 10 a.m. and 4.30 p.m. and 6.30 p.m. no stopping will be allowed, except in emergency, and for buses to pick up and set down passengers, and at traffic lights and pedestrian crossings. A welcome corollary of the scheme is the extension of loading and unloading bans at the intersections throughout the day and the marking of the route with traffic lanes to encourage lane discipline. The proposal has aroused considerable protest from traders and hoteliers situated along the route, but this should not be permitted to delay the plan's implementation. In many American cities such peak-hour restrictions have been successfully imposed, resulting in no great hardship and considerable improvement in traffic flow. Restrictive schemes cannot be introduced without evoking opposition but the test of their value is their overall effect on traffic conditions, as local inconvenience caused can generally be overcome by rearrangement of such matters as deliveries.

It is important to keep the radials leading to City centres clear for traffic but as long as the roads are crossed by conflicting streams and pedestrians, traffic will be subject to frequent interruption and the effectiveness of such measures will be limited. They can, therefore, be regarded only as palliatives and no substitute for radials of urban motorway type, the case for which is strongly made by Professor Fisher Cassie in his paper reproduced in later pages.

REPORT FROM

SWEDEN

ROAD and TRAFFIC PLANNING

by Erik Hasselquist

Chief Engineer, Royal Board of Roads and Waterways

IN November 1957 a specially appointed committee, which included road and traffic experts and specialists on economic and industrial geography and social planning, and representatives of industry and the motoring organizations, put forward proposals for a road network and investment plan for Sweden based upon investigations on the development and localization of the population, on industrial and economic trends in different parts of the country and on traffic developments in general. The Swedish Government has adopted in principle this 20-year road plan and, since 1958, investment in roads has kept close to the plan: regional plans (common summary plans for a number of communities), master plans (plans for one community) and town planning are all based upon it.

The programme for the development of the road network was not intended to be definitive: rather was it the intention to produce a skeleton plan which could be translated into an active programme by the working out of yearly plans, but could be successively revised in accordance with technical and economic developments. A continuous revision of the plan would thus be carried out in the light of new results and experiences in the relevant fields. In this way, it would also be possible to make use of, *inter alia*, the results of current investigations abroad, and it would be easy to adapt the plan to developments in other social spheres.

In the year 1955 the population of Sweden was about 7.3 million, of whom 5.1 million, that is 70 per cent, were living in built-up areas. An assessment based upon, among other things, developments to date, and upon certain assumptions concerning the continued flight from agriculture, the structural changes in the timber industry, the growth of the urban trades and industries, and the general building development in settled areas indicated that by 1975 80 per cent to 85 per cent of the population, about 7.8 million, would be living in built-up areas.

Investigations carried out with respect to industrial and economic development show, *inter alia*, that a continued mechanization and specialization in both stationary industry, and in building activities and agriculture, must be expected, entailing increased or new transport needs. With current transport tendencies in mind, it is most probable that these will be met by road transport. The present and continuing development with respect to surface transport leads to the prognosis—especially in view of the increased call for door-to-door service—that a continued switch to road goods vehicles for the shorter distances

Fig. 1. *Askeröfjord Bridge, part of a new major road project connecting the islands Tjörn and Orust, with the mainland. The bridge has a* 912-*ft. tubular steel arch with a clearance of* 135 *ft.* (Photo by the Contractors, Skänska Cementgjuteriet)

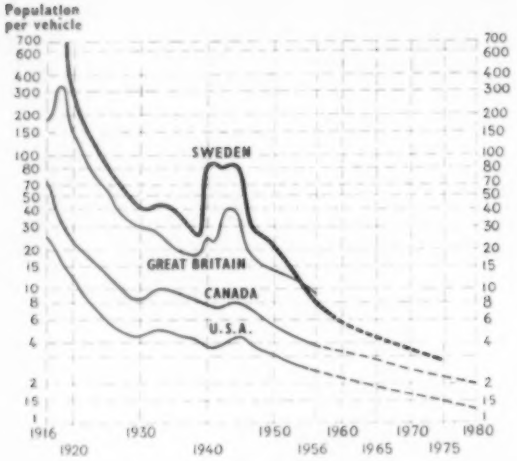

Fig. 2. Predicted growth in motorization.

is likely; at the same time new transport needs will be met by this transport form. The closing down of smaller railway lines may also be expected to contribute to the growth of truck traffic.

The future increase of production in stationary industry has been estimated to amount to about 3 per cent per annum. In view of the fact that the domestic movement of goods seems to be increasing more than production, a future annual growth of transport on the railways, by road vehicles and by water, is estimated at 4 per cent to 5 per cent. Allowing for the trend to road transport, a future annual increase in road goods transport of 7 per cent to 10 per cent has been assumed, and a four to six times increase by 1975 over 1955. Results of transport investigations for different branches of industry support this assumption. If the above-mentioned level for domestic goods traffic is reached, by 1975 one-half to two-thirds of the domestic goods transport in Sweden will be by road as against scarcely one-third today. By far the greater part of the assumed increase in passenger traffic in Sweden of a minimum of 3 per cent per annum is estimated to be in personal transport, primarily the motor car.

Growth in Personal Transport

An important feature of a modern industrial community is the marked increase in the daily journeys to and from work, and the purchase of motor vehicles for this purpose is facilitated in some industries by loans on favourable conditions.

As far as can be judged from developments in Sweden, no marked relative increase in personal transport over long distances need be anticipated. Expansion of domestic flying and express train traffic underlines this. Thus, as regards road passenger and road goods transport, one is probably justified in estimating that the main increase is likely to be in relatively short distance transport.

Among European countries, Sweden has gone furthest in regard to motorization. Whereas in 1950 there was one motor vehicle (motor cars, lorries and buses) to every 20 inhabitants, today there is one to every six inhabitants. (If motor bicycles and motorized bicycles are included, however, there is one motorized vehicle to every 3.5 inhabitants). According to an actuarial forecast, by 1965 there will be one motor vehicle for every 4.5 inhabitants and by 1975 one to every three inhabitants (Fig. 2).

If one assumes that in future the motor car is used on an average to the same extent as now, it will be responsible by 1965 for 75 per cent, and in 1975 80 per cent to 85 per cent, of the total number of vehicle/kilometres of public and private transport, compared with 55 per cent for 1957.

On the whole, from available data concerning the number of vehicles and traffic flow, it would appear that traffic growth follows, roughly, developments on the vehicle front. This emerges from a comparison of the factors affecting the traffic growth with the corresponding factors as regards vehicles. Investigations carried out with reference to traffic growth on different types of roads show that traffic—both the annual average daily traffic and the summer average daily traffic, June-August—tends to increase at a quicker rate on busier roads than on others. Thus, a comparison of the results of the 1936 and 1953 nation-wide traffic counts shows that on the majority of the national main roads, and the more important county roads, traffic during the period 1936 to 1953 increased by from four to five times as much, and traffic on the more local road network of the country districts by two to two and a half times that for 1936. On an average, traffic on all roads tripled during these years. The corresponding tendency is seen as regards the volume of summer traffic in relation to the annual average for daily traffic. The marked increase in recorded traffic during the summer months is also more pronounced on the national main roads than on the cross-country roads. The same applies to the latter in relation to other county roads.

Determination of Road Standards

The norms, proposed as a basis for future road standards, are determined with reference to the summer average daily traffic estimated for 1957. In certain cases where estimated traffic volume is so great that dual carriageways may be needed, variation in hourly traffic throughout the year is also taken into account. This is to preclude the possibility that the number of hours during the year when troublesome queue formation or traffic blocks occur may be more than can reasonably be tolerated when set against the great expense of the subsequent conversion of a two-lane road to a dual carriageway.

It may be mentioned that the total road transport for 1955 amounted to approximately 12,000 million vehicle kilometres. The multiplier in relation to the traffic for the year 1953, used in this connection for the different national main roads, varies for the year 1965 normally between 2.5 and 4.0, and for the year 1975 between 4.5 and 6.0. In certain cases, higher multipliers than those given above have been used for the calculation.

Extensive traffic counts and origin and destination surveys play a most important part in the preparatory work on which Sweden's road plan is based. Road traffic intensity is calculated from systematic traffic counts and the last manual count covering the entire country took place in 1936. Since then manual counts

have been made at 130 points seven times a year from Friday to Sunday in order to obtain information on the variations in traffic and its composition (Fig. 3) and on the increase from year to year (Fig. 4).

Since 1951, these counts have been supplemented with mechanical counts at control stations and cover stations. The former provide material for the annual variation curves for main roads and provincial roads within different districts, and results are published as printed traffic flow maps giving the average daily traffic volume for the year and for the summer months (June-August) for almost every public road (about 60,000 miles). These maps are based on counts of about 13,000 and 15,000 traffic streams and are available for the years 1953 and 1958 (Fig. 5).

The O-D surveys were made at special points spread over the whole country, and some 250,000 roadside interviews were made to obtain information concerning the origin, destination and purpose of the trips. The surveys were mostly restricted to one week-day during the spring or autumn and one week-day during the summer. In some cases, week-end traffic was studied also. The purpose of the surveys was primarily to reveal the origin-destination pattern of the traffic, and the relation between traffic to and through the principal urban areas along the present road network. The structure of long distance traffic, and the distribution of travel distances was studied at local observation points, as well as along the whole of a certain stretch of the road. The distribution of transport mileage between various travel distances and types of road was analysed. Furthermore,

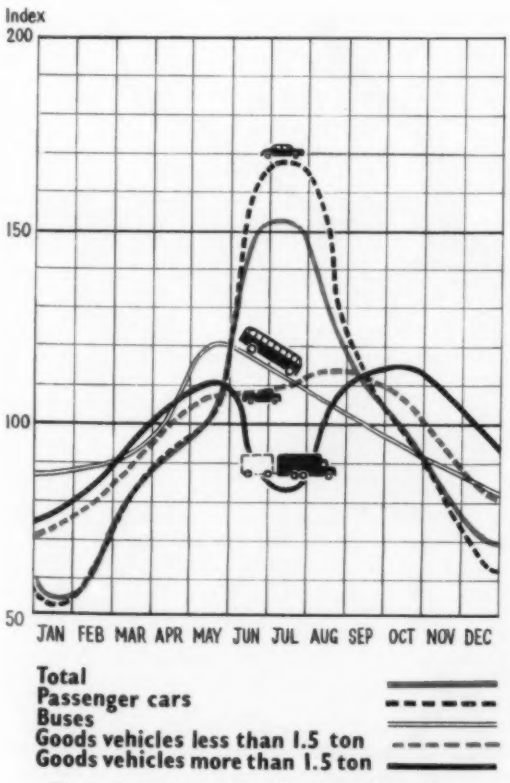

Fig. 3. Composition and traffic volume by months.

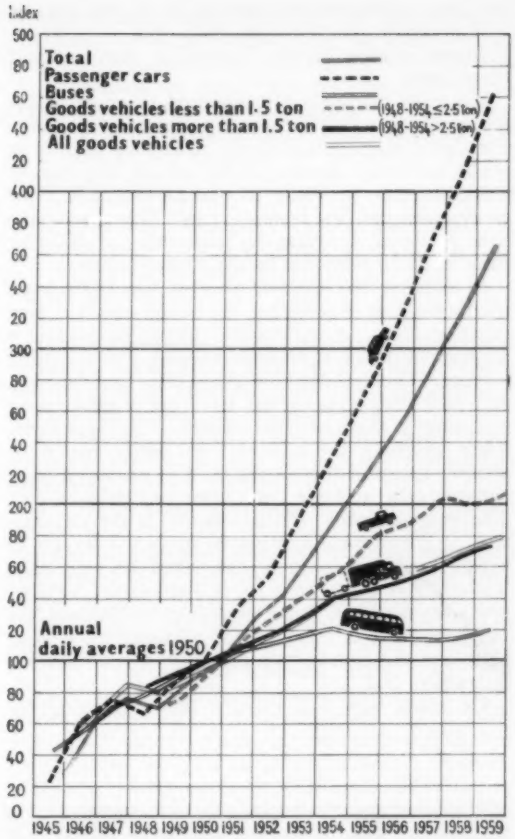

Fig. 4. Growth in motorization in Sweden and its composition.

analyses were made of traffic field structure around urban areas and along various types of roads.

To carry through, within reasonable time and costs, field work analyses of the data obtained, a sampling method was used. The method decided upon was to study during a certain period of the day—in most cases from 6 a.m. to 10 p.m.—the traffic flow at special points along the road, which were generally selected immediately outside urban areas. This made it possible to register both long distance through traffic and the more intensive local traffic to and from the area. The sampling method enabled each interviewed group to cover within one period of 16 hours two or three different stations outside the built-up area. All drivers passing the station in one direction within a quarter of an hour were interviewed. After a pause of five minutes, the interviews were resumed on the other side of the road for another 15 minutes, to cover vehicles travelling in the opposite direction. The interviewers were then given 20 minutes to move to another location where the same procedure was repeated. During the day, the personnel thus moved from place to place according to a fixed schedule. Each interviews usually took 20 to 30 seconds. The answers were recorded on a tape recorder and registered on punch cards. To facilitate the computation of travel distances with modern electronic computers and the co-ordination of the data obtained at different stations,

the places of origin and destination of each trip, as well as certain points on the road, were given in co-ordinates relative to the Greenwich meridian and the equator.

For road planning it is essential to know which roads are the most important to commercial traffic. For that reason, special kinds of surveys have been made to obtain figures of the annual number of ton/kilometres on roads of special importance for goods transport. For instance, traffic flow maps have been prepared, showing the importance of different roads used for transport by the timber industry.

In addition, the National Swedish Road Board has tried a method of weighing the traffic, which is now considered to be sufficiently tested to enable a programme to be instituted covering 210 weighing stations. The country is divided into five districts, and each district is served by a patrol performing weighings at three adjacent stations at the same time. After weighing for a week, the patrol moves to another group of three stations. The machines work automatically and are only inspected twice a day. The weighing plate, which is boxed in the carriageway, is dimensional and placed in such a way as to permit weighings of only one wheel on each axle. Recording is made on a paper strip as the vehicles pass over the plate. When weighings are finished, the weighing plate is removed and replaced by a wood plate and the instruments placed in a transportable instrument box.

On roads with heavy traffic flow, one weighing machine is placed in each lane of the carriageway. On smaller roads, there is only one weighing plate in one of the lanes; the other lane is shut off and the direction of every vehicle passing over the weighing plate is automatically recorded. A speed limit of 20 km/hr (12.5 miles/hour) is necessary for accurate recordings. The weighing machine also serves as a traffic counter, and it is possible to separate the registered vehicles into various classes according to the number, size and gaps of the axle load registrations. The weighing equipment used for these surveys has been developed at the Swedish Road Research Institute.

A closer study has shown that the present road network is ill-equipped to meet future traffic development. Bad traffic blocks and queue formation may be expected to be general, not only in the larger towns and at their approaches, but also on the many low standard roads which do not afford sufficient space for future development. Roads are becoming more congested, and the transport both of persons and goods is subject to increasing delay. At the same time, the accident curve is tending, despite many measures taken to regulate traffic, to rise in proportion to the growth in traffic.

For the road inventory two cars are used and their equipment includes radio transmitters and receivers. trip odometers, inclinometers, superometers, gyro-compasses and wire recorders. All data relevant to road standards are recorded: road section, type of surface, curvature, gradients, super-elevation, inter-

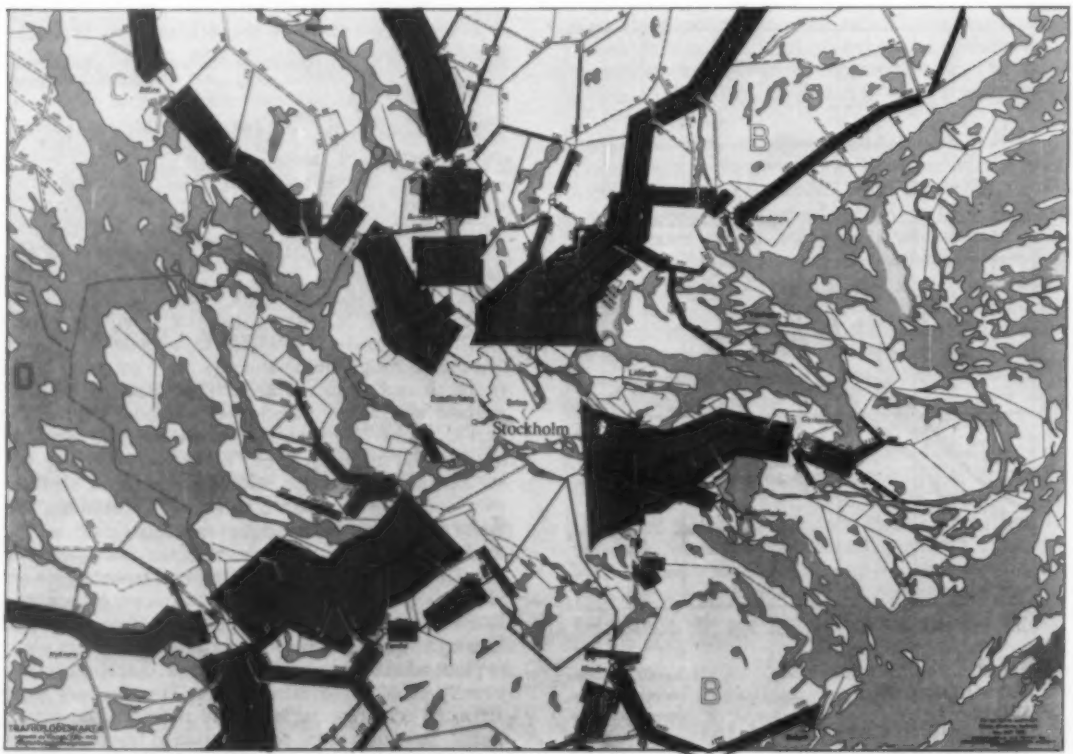

Fig. 5. Traffic flow map for the outer area of Stockholm showing annual average daily traffic (black band) and average daily traffic during summer time (enlarged band in red). Maps of this type are made up for a number of more densely populated areas.

sections, bridges and underpasses, roadside obstacles, off-street parking spaces and visibility, both on the road itself and at intersections. Data has been obtained for all national main roads—about 9,000 miles.

The priority classification is based on such data. Within a scale of 100 points, technical standards (condition of road surface, bearing capacity), driving conditions (width of carriageway, alignment and passing possibilities) and road safety (width of carriageway and shoulders, stopping distance, unity of alignment and accidents hazard), have been given 25, 30 and 45 points. The sum of points received for each part of the road is then corrected in relation to the traffic volume. For these purposes a special formula is used. The standard of 100 points is the standard that fulfils the design standards now in use. For each road a diagram is drawn up which shows the sum of points for each section along the road.

Classification and Standards

The road plan includes the following classes of road, all of which are to have a carrying capacity of 10 tons axle-load and 18 tons bogie-load:

(a) Divided highways, median strip and wide bearing shoulders. Width of pavement 7.0 m. (23¼ ft.), width of median strip normally at least 7.0 m. and width of shoulders 3.0 m. (10 ft.). Paved, 0.5 m. (1¾ ft.) wide border strips directly adjacent to the pavements, constituting part of the median strip and the shoulder. This type of road is constructed either as a freeway with grade separated intersections or as a four-lane road with at-grade intersections where the terrain and the traffic conditions do not call for grade separated intersections. Design speed for freeways is 120 km./hr. (75 miles/hr.) and for other roads 100 (62 miles/hr.) to 120 km./hr.

(b) (1) Road with 7.0 m. wide pavement and 3.0 m. wide bearing shoulders. In the case of larger volumes of traffic, 0.5 m. wide paved border strips are constructed on the shoulders directly adjacent to the pavement. Special shoulder parking facilities are to be provided where this is considered necessary. Design speed is normally 100 km./hr.

(2) Road with 7.0 m. wide pavement and 1.0 m. (3¼ ft.) wide bearing shoulders. Regular shoulder parking facilities provided along the road. Design speed normally minimum 80 km./hr. (50 miles/hr.).

(3) Road with 6.0 m. (20 ft.) wide pavement and 1.0 m. wide bearing shoulders. Shoulder parking facilities are provided where considered suitable in the light of the traffic conditions obtaining. Design speed is normally minimum 80 km./hr.

For two-lane roads in hilly country special lanes should be provided on steep up grades for the slower truck traffic. Divided roads with two three-lane pavements are deemed necessary in certain cases. It has not been thought necessary to deal specially with such roads, as it may be assumed that they will be found only locally and will then be given special consideration. This classification for the national main roads may also be applied to county roads. As a rule, however, the requirements for design speed should be made less stringent because in the main they will serve local traffic only.

Since in addition, a large number of county roads will, according to calculations, be carrying a relatively inconsiderable amount of traffic, the committee thought it possible to reckon also with smaller road widths than the standard proposed for national main roads, with 6 m. wide pavement and narrow shoulders. Types of road that have been considered are those with 6.0 m. pavement without shoulders, and one-lane roads in this connection with 3.5 m. (11½ ft.) pavement and passing facilities. The former type is presumed to be the normal type for county roads, and it is proposed that the latter type should only be considered for roads carrying very little traffic, e.g. roads in the less developed areas.

The volumes of traffic for the time being proposed as a basis for the design of the network of national main roads are:

Type of road	*Future summer average daily traffic*
A	9,000
B:1	3,000-9,000
B:2	1,500-3,000
B:3	1,500

For county roads a 6 m. pavement and narrow shoulders are proposed to be used for design traffic volume between 1,000 and 2,000 and 6 m. pavement without shoulders for volumes between 150 and 1,000. For lesser volumes than 150 vehicles, a 3.5 m. pavement with passing facilities is considered sufficient.

The road plan, in contradistinction to earlier official road building programmes in Sweden, is based upon a detailed inventory of actual need, and is regarded as a solid basis for an investment plan.

For the roads in the county districts, the development has been estimated to cost a total of £1,120 million and it is proposed to make at least 55 per cent of the investment in national main roads and extremely important county roads during the 10-year period, 1958-1967, and the remainder after 1967. For other county roads, 20 per cent during the period 1958-1967 is considered reasonable. Such an allocation has been deemed fully justified because of the urgent need to improve the more heavily used and industrially important roads. Thus, during the years 1958 to 1967 nearly 40 per cent of the total expenditure in the country districts will be invested. About half, or £220 million, will be for national main roads.

Financing the Programme

As to state assistance, the towns obtain 95 per cent of the cost of road investment and maintenance (roads and streets of importance for through traffic), and it has been estimated that, including both national main roads and local roads, that this will amount to £290 million. In allotting investments to the two periods, it has been assumed that 65 per cent of the investment requirement for the national main roads in the towns would be met during the years 1958-1967. The traffic difficulties that may be expected on the approaches to the towns thus seem to justify a greater immediate contribution in the towns than in the country districts. For local town roads it has been assumed that about 30 per cent of the investment would be made during the first period and approximately 45 per cent of the investment need would be met during the period 1958-1967. According to the investment plan, investment in roads in the country districts will increase from £22 million in 1958 to £71 million in 1967. In a corresponding way, the investment for the towns will increase from £7.3 million to £20.6 million. According to the calculations these costs, as well as those for maintenance, will be covered by the funds that, on the basis of current taxation, will accrue from motor vehicle traffic.

American Report

The Miles Trainer at RoSPA House with the common but incorrect grip on the steering wheel being demonstrated.

KEYS to ROAD SAFETY

by Dr. Francis S. McGlade, B.S., M.A., Ph.D.

The Associate in Safety Education at the National Commission on Safety Education, National Education Association, Washington, describes the influence of driver education and driver improvement programmes in promoting road and traffic safety in the United States.

THE motor vehicle is prominent among the inventions and concepts that have done most to change the economic, social, and cultural patterns of American life in the past half-century. It has been a major impetus to the rapid development of the standard of living and the diverse uses of leisure time. Through a multitude of experiences, it has run the gamut of transition from a luxury to a necessity. Unfortunately, the motor vehicle has also posed some vexing problems which have proved difficult to solve. Paramount among these is the loss of lives and property resulting from motor vehicle accidents. Each year there are upwards of 38,000 traffic deaths, more than 1,350,000 traffic injuries, and over 11,000,000 traffic accidents resulting in economic losses estimated in excess of $6.5 million.

A traffic accident is an exceedingly complex occurrence caused by many related, and some seemingly unrelated, factors. The one predominant factor in virtually every motor vehicle accident is that of driver behaviour. Human behaviour, which is the manifestation of the interaction of habits, attitudes, emotions and other characteristics of the individual, is a dynamic and transitional force. It would appear that the one constant in human behaviour is its inconsistency. The human factor in the incidence of motor vehicle accidents is difficult to define accurately because of the effects of temporary and constantly changing conditions on the individual.

There are three basic approaches that have demonstrated effectiveness in combating traffic accidents—education, enforcement, and engineering. A sound traffic safety programme combines these three essential elements into a unified attack on the problem. Enforcement and engineering are the immediate approaches, the here-and-now methods. Enforcement attempts to obtain compliance on the part of drivers to the traffic laws and ordinances. Engineering attempts to make it as difficult as possible for accidents to occur, by designing streets and highways, and traffic signals and markings, so as to facilitate traffic flow and reduce driving to a minimum of complexity. Traffic safety education, or 'human engineering,' is the longest process of the three 'E's', but, in the final analysis, it is also the most durable and effective.

Two facets of the total traffic safety education picture are the programmes for driver education and driver improvement. Driver education in the United States is primarily a function of the secondary school in its role of teaching youth to do better those things they will do anyway. Its purpose is to teach beginner drivers how to operate a vehicle safely and efficiently and how to provide a sound basis for a lifetime of safe motor vehicle operation. An effectively organized driver education programme plans and carries out many separate learning experiences, each designed to satisfy specific needs of the students at different stages of their progress. Thus, what students learn at a given time depends on the basic objectives of the programme, the students' present interests and knowledge, and the materials and equipment used which include current types of vehicles and changing road and traffic conditions.

The programme is built around the following objectives:

(1) Development in young people of a strong sense of personal and social responsibility for the common welfare, particularly as it is affected by the operation of motor vehicles.
(2) Development of pride in maintaining high standards of performance in the use of motor vehicles.
(3) To foster effective habits of co-operation in solving public problems, especially those concerned with the use of motor vehicles and highways.
(4) To promote the safe, efficient and rewarding use of motor vehicles.

These objectives were recommended by the National Conference on Driver Education at Purdue University in 1958. This same conference also recommended minimum time standards for a complete driver education course consisting of both classroom experiences and practice driving instruction. The minimum recommended time standards are 30 hours for classroom work and six hours for behind-the-wheel instruction. Driver education is included as an integral part of the secondary school programme, and is offered at the grade level nearest the legal driving age, which varies from state to state. In this way, students receive driver education when their interest in learning to drive is at its peak. The classroom phase of driver education is designed to imbue students with the knowledge essential to good driving; knowledge of the traffic rules and regulations, the place of motor vehicle transportation in American life, characteristics of streets and highways, relationship of drivers to non-motor vehicle traffic, causes of traffic accidents, and human capabilities and limitations for driving and walking. Interwoven through all segments of classroom instruction is the attempt to develop among students a positive attitude toward safe driving. Attitude appears to be the most important single factor in human behaviour as it relates to safe driving and, consequently, a great deal of stress is placed on the development of those attitudes through wholesome experience in which students participate, which lend themselves to safe driving.

Practice in driving provides young people with instruction and practice in safe and efficient motor vehicle operation with the application of the knowledge and attitudes learned in the classroom. This is achieved through a series of planned learning experiences at the controls of a vehicle under the supervision of a qualified instructor. In addition to six hours behind-the-wheel, each student also spends 18 hours in the back seat observing other students drive, and this provides vicarious learning for the observer.

Driver Education Results

There is conclusive evidence that youthful drivers have more than their share of accidents, and there is a preponderance of evidence that youthfulness lends itself to accident susceptibility. These are exhibited by personality characteristics such as over-aggressiveness and resentment toward authority.

At least 30 studies have demonstrated that driver education is significant in reducing traffic accidents and violations by comparisons of groups of trained drivers with untrained drivers. A major point of criticism regarding the validity of these studies has been the difficulty of developing suitable experimental designs for them. Experimental control in studying human behaviour is an extremely subtle and complicated matter of design and execution. This seeming contradiction of terms does not negate the value of these studies. Out of this recognition of the weaknesses in their design has come concerted effort to develop more scientific procedures in experimental design, as is being done in current studies. Allowing for these weaknesses, it has been shown beyond dispute that those who have had driver education have better driving records than those who have not. This is particularly true of the male population, and in some cases trained male drivers have had up to 50 per cent fewer accidents than untrained males. This shows that driver education is meeting a current need, and consequently is a proper function of the schools.

Driver Improvement Clinics

Driver education may be viewed as preventive maintenance, which is also a function of the initial driver licensing examination: to give the driving privilege only to those persons who demonstrate suitable driving performance. Driver improvement programming may be regarded as an attempt by the driver licensing agency to cure those licensed drivers who have fallen prey to the ills of accidents and violations. Some drivers display adequate performance to enable them to obtain a driver's licence, but at a later date they are involved in a series of accidents and/or violations. Some, after a brief period of incurring accidents and violations, again become accident and violation free drivers. So it appears, in many cases, that accident susceptibility is a transitory rather than a stable situation and is shown by the fact that the chronic violator and accident repeating groups constantly shift from year to year.

The driver improvement programme comes into the picture when a driver has experienced accidents and/or violations beyond a given point; it is now time to determine if the driver's licence should be revoked or if the erring driver can be helped through the driver improvement clinic. The clinic does not attempt to alter enforcement policies for dealing with traffic offenders. Rather, it is an additional effort to reach those drivers who are apparently unaffected by fines or the loss of the driving privilege. Driver improvement is based on the assumption that many poor drivers, particularly those for whom poor driving may be only a temporary state, can be rehabilitated through a well-defined course of study in driver education conducted by qualified instructors, and returned to the roads as safe drivers.

The utilization of a clinic to improve performance of problem drivers was inaugurated in Detroit in 1928 by a judge who requested that a study be made of 100 traffic offenders who had been brought into court for violations of traffic laws. This first clinic was primarily concerned with psychological and psychiatric cases.

Today many States employ a points system as the basis for selection of violators to be sent to the improvement clinic. Under the points system, each type of traffic violation has a specified number of points assigned to it, and when a driver receives a given number of points against his driving record within a certain period, he is subject to action by the driver licensing agency. This may take the form of a hearing, suspension, immediate revocation of the licence, or enrolment in the driver improvement clinic. The driver is usually sent a warning letter

before he has sufficient points to be called in by the licensing agency, and this has proved to be very effective, as will be noted later.

It is estimated that today there are over 100 driver improvement clinics in the United States, but there is wide disparity in the quality of instruction offered. In some it is merely a routine process of showing safety films and administering psycho-physical tests; others have failed because of the lack of results due to the poor quality of the programme. The better clinics employ driver education teachers or other qualified personnel to teach, who develop courses of study which include lecture and discussion periods in addition to films and testing equipment.

Clinic Results

The experience in the various licensing jurisdictions that operate driver improvement clinics has not been extensive enough to predict with any degree of certainty exactly how many lives have been saved, or how many accidents have been averted, through driver improvement programmes; but there is substantial cause for optimism.

A recent study in the State of North Carolina indicated that drivers with no known violations averaged 0.167 accidents per driver. Drivers with five violations against them averaged 1.001 accidents. In another study it was demonstrated that violators who receive a warning letter from the driver licensing agency have significantly fewer subsequent violations than violators who are not warned. Thus, if the number of traffic violations is a sound criterion for predicting accident involvement, and if violations are reduced by warning letters, then we may assume that such letters reduce accidents. In North Carolina warning letters were sent to over 40,000 violators last year, which probably resulted in a marked decrease in violations and accidents. One cannot question the additional value of exposing to a driver improvement programme those few violators who do not respond to warning letters.

Future Outlook

Ordinarily, it is dangerous to venture into the psychic realm of prediction. Boldness and a venturesome spirit are not prerequisite, however, to making optimistic prognostications about the future of driver education and driver improvement programmes. There is evidence, both experimentally and empirically derived, to support the expansion of these programmes in the interest of greater road and traffic safety.

Over 12,000 of the 20,000 high schools in the United States now provide driver education. In many communities the programme is also offered to adults during the evenings and in summer programmes, and many states give financial assistance to schools giving driver education. The number of schools providing such courses and the number of individuals enrolled in them is increasing each year. Educators, organized community and private groups are becoming more and more cognizant of the role of driver education in meeting a vital national need. The next decade should see 90 per cent of eligible youth receiving first class instruction in safe driving.

Driver improvement clinics are a relatively new device in driver licensing administration, but already their potential value has been demonstrated in several States, notably North Carolina. They provide the optimum of effort by the driver licensing authority to improve a driver's conduct without taking away the driving privilege. It can be conjectured that the gradually diminishing traffic accident rate in North Carolina, which largely coincides with the driver improvement programme, is an indication of the significance of this programme in reducing traffic accident violations. With the current high quality driver and improvement clinics setting the pace, before long a majority of States will have adopted such programmes and will be reaching a high percentage of those violators who would benefit from such a clinic.

Driving Reaction Test Certificate

NAME.....

Your reaction time was.....seconds.

In this time, at 30 m.p.h., your car would travel.....feet **before** you applied the brakes. Your reaction time is that period of time between your recognition of an emergency, and taking the appropriate action.

REACTION TIMES IN SECONDS	M.P.H. 10	20	30	40	50	60	70	80	90	DISTANCE TRAVELLED IN FEET
.25	3.5	7.5	11	14.5	18.5	22	25.5	29.5	33	
.3	4.5	9	13	17.5	22	26.5	31	35	39.5	
.35		10.5	15.5	20.5	25.5	31	36	41	46	
.4	6	11.5	17.5	23.5	29.5	35	41	47	52.5	
.45	6.5	13	19.5	26.5	33	39.5	46	52.5	59	
.5	7.5	14.5	22	29	36.5	44	51	58.5	66	
.55	8	16	24	32	40.5	48.5	56.5	64.5	72.5	
.6	9	17.5	26	35	44	53	61.5	70.5	79	
.65	9.5	19	28.5	38	47.5	57	66.5	76	86	
.7	10	20.5	31	41	51.5	61.5	72	82	92.5	*
.75	11	22	33	44	55	66	77	88	99	
.8	11.5	23.5	35	47	58.5	70.5	82	94	105.5	
.85	12.5	25	37.5	50	62.5	75	87	99.5	112	
.9	13	26.5	39.5	53	66	79	92.5	105.5	119	
.95	14	28	42	55.5	69.5	83.5	97.5	111.5	125.5	
1	14.5	29.5	44	58.5	73.5	88	102.5	117.5	132	

In addition to the above must be added the effective braking distance of your car. This distance will be dependent upon such factors as the condition of your brakes and tyres, the state of the road surface, weather conditions and the weight of your vehicle at the time.

In the interests of Road Safety we urge all car owners to visit their local service garage to ascertain the minimum distance in which they can bring their car to a stop **after** they have applied the brakes and that their brakes are working at maximum efficiency.

Signed.....

Authorised BSM representative

**National Average*

The British School of Motoring certificate showing reaction time to road hazards in simulated driving conditions, presented to all undergoing a test on their static-trainer.

ECONOMIC ASPECT of ROAD ACCIDENTS

by **Jacques Thédié and Claude Abraham**

French Highway Engineers ask how much should be spent on accident prevention to save lives.

THERE are a number of methods of fighting accidents: all of which involve expenditure or interference with traffic. Their total elimination is not impossible in theory, but it would involve so considerable an outlay and such difficulty, that it has to be regarded as quite impossible and incompatible with a modern society. The question is where should a halt be called? How should a choice be made among the different means of prevention? By what criteria should the extent of expenditure and the nature of preventive measures be determined?

These questions were asked at an early stage by economists specializing in capital investment in roads. In recent years a large number of papers have been devoted to the subject, in spite of the understandable reluctance of those who consider any attempt to set a value on human life to be sacrilege. It was to take action against this reluctance that the Eleventh International Road Congress concluded:

> 'However repellent it may be to assess human life, it does not seem that such a valuation can be dispensed with, difficult though it is'.

Careful attention will be given to this concept of the valuation of life and of what it actually covers, but first of all it is useful to recapitulate the main calculations so far made.

I. Classical Investigations of Accident Costs

In the economic field, expenditure is considered justified if possible saving exceeds expenditure. It therefore seems logical to try to assess the cost of accidents and the amount saved by their avoidance; besides, by calculating the total cost of road accidents for a determined country, it is hoped to establish numerical data with which to draw the attention of the authorities to the importance of road safety.

On analysing the main publications on the subject three distinct categories emerge: one based essentially on the statistics of the insurance companies and the valuations of the courts; a second attempts to arrive at the cost by direct appeal to users; a third tends to analyse the strictly economic factors, to the exclusion of all others, and in particular the affective factors.

After a critical examination of these different methods, a method of valuation will be proposed which allows for both the economic and the affective factors.

Two questions will be asked for the sake of evaluation of each method:

> To what concept of the cost of accidents does it answer (cost to users, cost to the nation, including or excluding affective factors? Is this concept the only one to be retained for the aim set?)
> Does the method provide a good estimate of the cost to which it corresponds?

A. Insurance and Courts

The most convenient method of assessing the cost of accidents is to refer to the statistics of insurance companies. This is the method adopted in particular by Reinhold[1] and Duchez[2]. An important correction is nevertheless necessary to pass from the risks covered to the total cost of accidents, because most users are only insured against third party risk. Nevertheless, the method is precise enough.

To what concept of the cost of accidents does it correspond? The insurance companies indeed pay the compensation as valued by the courts, if judgment is given, and what the probable valuation would have been in the event of a friendly agreement. To answer this question, the decisions of the courts must be examined.

This was done by Jones[3], and not so much with the aforementioned object, as to arrive directly at an estimate of the cost of accidents. However, as a method of valuation, this is somewhat inaccurate owing to the extreme variability of judgments. But the judgments of the courts and the estimates of insurance companies cover the same concept of cost. If this cost has to be estimated, it is therefore better for this to be done by the most accurate method, i.e.

by the insurance statistics. Nevertheless, a study of court awards remains indispensable for knowing what this estimate contains. This will be examined later.

B. Direct Estimates

Insurance statistics can only be used at the cost of various hypotheses, extrapolations and manipulations if the losses actually sustained by users from the sums paid out by the insurance companies are to be determined. One may therefore be tempted to approach road users direct to ascertain the whole of the loss they have sustained. This method has been employed in the United States by Dunman[4]. It has the great merit of avoiding some of the difficulties of the previous method, but it calls for investigations of wide scope and is very costly. Further, the cost of accidents to road users does not coincide with their cost to the nation and it is this that must now be examined.

C. Economic Estimates

The fault found by economists with the preceding two methods is that they claim to ascertain the cost of accidents from the point of view of users, and that they moreover include non-economic factors, such as refund of affective losses. Purely economic investigations, of which that of Reynolds[5] is the prototype, but among which those of Ramaker[6] and Hosse[7] may also be mentioned, only aim at determining the actual losses caused by accidents, the enumeration of which is taken from Reynolds:

Material losses, consisting above all of damage caused to vehicles.
Medical cost.
Administrative expenses, mainly the working expenses of insurance companies.
Net loss of production of persons killed or injured, *i.e.* difference between future production and consumption.
Loss due to the existence of a population that is smaller than it should be.
Effect of income transfers.

Now the indemnities paid by the insurance companies (apart from problems of shared liability) comprise:

Actual compensation (material or medical expenses).
Compensation for loss of wages, or compensation paid to the victim's next-of-kin in the event of death.
Compensation for affective losses (*'pretium doloris'*, for instance).

The second factor, in the case of death, varies considerably as a function not only of the economic status of the victim, but also of his family status: the death of an unmarried orphan student costs nothing to the insurance companies. Part of the cost to the nation is therefore excluded from the cost to the insurance companies.

As regards the third factor this is not, economically speaking, a cost, as correctly noted by Reynolds. It is a transfer.

The conclusion that can therefore be reached is that the *cost of accidents to the community*, the only correct estimates available are those attempted by Reynolds, Ramaker and Hosse, although they must be criticised for slightly incorrect formulation in calculating the net loss. If, therefore, one were content to estimate the loss incurred by the community owing to road accidents, all that would be necessary would be to recapitulate the investigations of the authors already quoted, merely stating how, in our opinion, the calculation of the production losses should be made. In fact, however, our aim is a very different one. What we are setting out to do is to find a rule making it possible to decide on a certain investment, or refusing it.

In so far as accidents only have consequences of an economic order, the above investigations furnish a reply. But accidents also have consequences of an affective order (physical and moral pain, or death). No one would consider not allowing for these by the acceptance of an additional outlay. But what outlay? The kernel of the problem resides in the allowance made for loss of human life, and we now examine this point in an attempt to answer the question: What part should losses of human life play in economic decisions?

II. Human Life in Economic Decisions

It is often thought absolutely scandalous to involve human life in economic decisions for a precise, fixed value. It is quite certain that human life has no worth that can be measured, and there is no point in trying to do so. Yet, every day, decisions are taken. A crossroads is laid out, but a sharp turn remains. Some hospitals are built. Why not more? Certain sums are spent on medical research. Why not larger or smaller amounts? Each of these decisions 'attributes unconsciously in each case a value to human life and suffering. It seems preferable to make this more conscious and systematic'[8].

Indeed, in different domains, sums are spent which are intended, in one way or another, to save human life or to avoid suffering. It is indispensable that the greatest possible number of lives should be saved and the greatest possible amounts of suffering avoided. Moreover, certain expenditure does not merely result in a decrease of the accident risk, but also in a saving of time and money. Investment decisions will only become homogeneous if the question is answered: How much should a community agree to spend to save one human life?

It will then be perceived that neither the calculations taken from the insurance companies nor strictly economic calculations make it possible to give a strict reply to this question. The former overlook the unmarried orphan, to refer again to an example already mentioned. The latter, as may readily be appreciated, lead to regarding as desirable the death of a man who has ceased all activity. In other words, it does not follow that because the death of an individual costs the community nothing, no attempt should be made to avoid it.

If a miner is imprisoned at the bottom of a pit, if a mountaineer is in danger up in the mountains, if a vessel is in danger of shipwreck on the high seas, it would be criminal to reckon efforts and money according to the number of human lives to be saved. It would be vain to inquire whether the sum spent on saving these few lives if invested elsewhere (on roads for instance) might not have enabled more lives to be saved. It is impossible to weigh in the balance certain deaths and probable deaths, even if the latter are in greater number. The assessment we are going to attempt calls for anonymity and therefore we can only deal with small risks, minor probabilities. When we

talk of saving a human life, the question is really only one of avoiding a probable death, resulting from the multiplication of a slight probability by a large 'population'. Besides one never knows how many victims a given work has effectively avoided. The circumstance that accidents obey the laws of chance further enhances the anonymity of the possible victims, since it is never known how many victims there might have been, had there been no intervention.

However, this anonymity is not as complete as might appear on an initial examination, for even if the identity and the name of the probable victims are unknown, some of their average characteristics are; for instance, as regards roads, it has been found that the distribution of victims according to sex or age is extremely stable from year to year, and it is quite likely that the same regularity would be found if there were sufficient statistical data concerning the social and professional categories.

Therefore, for a well defined total risk, for instance, that produced by road traffic, the share in this risk that is supported by a determined category of individuals is known. Allowance can be made for this factor in the calculation of the acceptable expense.

This being the case, it is quite obvious that the estimate we are attempting cannot be the outcome of purely objective data. It is not therefore possible to hope, even with the aid of most elaborate calculations, to arrive at a strict determination of the value to be taken into account for human life in economic decisions. This value should in fact be the outcome of a collective decision; after all, it is the whole of the nation which should decide on the expense to be permitted for saving one of its members. In the face of the inevitable divergence of opinion, how should a choice be made? In the ultimate resort, it is only the government of the community that can make a decision, after taking into account public opinion. Such a decision would have the merit of clarity and would be perfectly logical. The placing of a value on human life thus appears to be a governmental problem. All the economist can do is to guide the government in its decision and enlighten it as to the factors involved. It is nevertheless to be imagined, in the present state of opinion, that it would be very difficult for a government to take a public stand on this subject. We should then attempt to reach a figure ourselves and regard it as valid in the domain of the decisions we are to take.

III. Attempt at Assessment

Two points of a general nature must be defined before proceeding with the valuation proper.

First, let us suppose that the death of an individual involves a consequence 'a'. The death of another individual entails a consequence 'b'. Let us imagine that we can assess at A the sum we agree to spend to avoid 'a', and at B that agreed to avoid 'b'. If the death of a third person entails both 'a' and 'b', we shall admit that it will be agreed to spend A + B to avoid 'a' and 'b'. If this hypothesis arises of its own accord for property damages, it does not seem to be absolutely obligatory for consequences of an affective nature, for instance.

Second, let us now consider the same factor 'a', this time occurring at two different times—today and in ten years' time, for instance. Economic theory teaches, in the case of material property, that the value of this single factor differs according to the time at which this property is available, even in the absence of any form of currency devaluation. The concept of 'actualization' is then introduced and the 'actual value' of any future sum is calculated by writing:

Actual value of the sum 's' available in year 'n' =

$$s_n = \frac{s}{(1+i)^n}$$

'i' is termed the 'rate of actualization'

It is only possible to compare with one another sums that are actualized at the same time.

It can be shown that this formula is applicable even if the sum 's' concerns the assessment of a non-material asset. In other words, it would be agreed to spend today a smaller sum the more distant is the suffering to be avoided.

The choice of the rate of actualization in itself is a problem for the government. We shall adopt in the effective calculations eight per cent.

By virtue of the principle of additivity mentioned above, it now remains to examine separately the expenditure agreed on to avoid each of the consequences caused by accidents. We shall therefore take one by one the factors listed by Reynolds, adding affective factors to them.

A. Material Damages and Medical Expenses

Material damage and medical expenses constitute for the community a direct loss of substance, a waste of productive time. It is logical to agree to spend, at most, their total value in order to avoid these losses.

B. Administrative Expenses

These are essentially the cost of operation of insurances. There is no question of avoiding all accidents. A distinction must therefore be made carefully between the working expenses, i.e. those resulting from the very existence of insurance companies, and those which are the outcome of the accidents themselves. In other words, we must find out the administrative cost of the marginal accident, it being noted that this marginal cost can in certain cases be what economists term a 'regressive cost'. Analogous considerations can be developed as regards the police and law courts.

C. Production Losses

The death of an individual entails a drop in production in years to come, therefore a decline in wealth, and it seems logical to agree to spend the present (actual) value of future losses to avoid this loss. But what is lost in reality? The individual would have produced, but he would have consumed. What the nation has lost is the dead man's production (gross loss) less his consumption. The difference is termed net loss. It is only this net loss that it seems legitimate to allow for. But it can equally well be considered, however, that the gross production is a measure of the nation's power and the government may for this reason decide to take the whole into account. A choice should therefore be made between these two solutions, or any intermediate solution.

Further it is essential to take into account free

services not included in the nation's accountancy, in particular the services performed by housewives. The national production and consumption should be increased accordingly. It must be noted, however, that these free services play very little part in the concept of power, and are in practice fully utilized within the family circle. Therefore, it seems that if the gross loss is deemed to be valid, there is no reason to include free services. It is only in the calculation of the net loss that it appears legitimate to include them. The figures will show moreover that the taking into account of free services has little influence on the general result. On the other hand, it is essential, unless absurdities are to be arrived at, in the classification according to age, sex and, possibly, social and professional categories.

Another difficulty arises from the fact that the loss of production is not certain; it depends in fact on the level of employment in the country concerned. Under conditions of acute unemployment, the loss of an active individual may have no effect on production. As a long-term view, the probable loss may depend on the level of population of the country in relation to its demographic optimum. It should also be noted that this reasoning does not really hold good for the free services performed whatever the level of employment —they even tend to have a compensating effect.

Assuming that the free services are independent of the level of employment, we are able to formulate this reasoning as follows:

Let U and V be the present (actual) values of future consumption and production of the victim in terms of national accountancy (i.e. excluding free services) U′ and V′ the actual values of future consumption and production as regards free services.

The total gross loss, against the background of the power of the country, is pV, where 'p' is a coefficient that characterizes the mean level of employment, in a long-term view.

The total net loss is then $pV - U + V' - U'$ and since a choice is possible between net loss, gross loss and any intermediate figure, the loss to be taken into account is a weighted average of the two and can be written:

$$pV - k(U + U' - V') \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

it being possible for k to assume any value between 0 and 1, and denoting the government's choice between gross loss and net loss.

Production and Consumption Losses

Let us consider a group of individuals of given age, sex and social and professional category. To know the actual value of future production and consumption it suffices to study the probable development of this group by allowing year by year for the probable number of survivors, the probable number of active persons, the total value of future production and consumption which is actualized for the year of the calculation. It is assumed that the variations of production and consumption with age on the one hand and with time on the other, are known.

Active Population

The active population is divided into social and professional groups of index 'q', men and women being separated.

Let:

A_n^q = the number of active individuals of age 'n' in the social and professional group 'q', at the start of zero year.

x_n^q = the rate of survival at age 'n'.

of A_n^q individuals live at the beginning of zero year.

$A_n^q \times x_n^q$ live at the start of year 1

z_n^q = the rate of survival of activity at age 'n'

Of A_n^q individuals living at the start of zero year

$A_n^q \times x_q^n \times z_q^n$ remain during active year 1.

P_n^q = mean production of an individual of age 'n' in group 'q' in zero year.

C_n^q = mean consumption of an individual of age 'n' in group 'q' in zero year.

d_v^q = the rate of mean increase of consumption in group 'q' from year v − 1 to year 'v'.

b_v^q = rate of increase of production in group 'q' from year v − 1 to year v.

a = rate of actualization.

U_n^q the actualized value in zero year of the future consumptions of individuals of group 'q' of age 'n' at the start of zero year, per individual.

V_n^q the actualized value in year zero, of the future productions of individuals of group 'q', of age 'n' at the start of zero year, per individual.

Formulae (2) and (3) on facing page follow immediately from these definitions:

If d_v^q and b_v^q are assumed to be constant (and denoted by $_d{}^q$ and $_b{}^q$) we then find formulae (4) and (5).

Inactive Population

The inactive population comprises two classes of individuals: those who will no longer be active (whether they have been so or not), and those who are destined to become active.

(2-1) Individuals who will no longer have any activity. Their future consumption is easily calculated from formula (2). Their future production is nil.

(2-2) Individuals who will become active:
These are the child population—schoolchildren or students.
If Sn is the population corresponding to age 'n' (1)

u_n^q = the fraction of this population destined to work in future in group 'w'.

t_n^q = the 'rate of survival' of inactivity at age 'n' for the population destined for group 'q'.

W_n^q = the actualized value—for the future production of inactive individuals of age n destined to belong to group 'q', per individual.

We then find formula (6).

If the whole inactive population of age n is concerned we may take formula (7) as follows:

$$W_n = \sum u_n^q \times W_n^q \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$U_n^q = C_n^q + \sum_{i=n+1}^{\infty} \left[C_i^q \left(\prod_{j=n}^{j=i-1} x_j^q \right) \left(\prod_{v=1}^{v=i-n} \frac{1+d_v^q}{1+a} \right) \right] \quad \text{.....(2)}$$

$$V_n^q = P_n^q + \sum_{i=n+1}^{\infty} \left[P_i^q \left(\prod_{j=n}^{j=i-1} x_j^q \, z_j^q \right) \left(\prod_{v=1}^{v=i-n} \frac{1+b_v^q}{1+a} \right) \right] \quad \text{.....(3)}$$

$$U_n^q = C_n^q + \sum_{i=n+1}^{\infty} \left[C_i^q \left(\prod_{j=n}^{j=i-1} x_j^q \right) \left(\frac{1+d^q}{1+a} \right)^{(i-n)} \right] \quad \text{.....(4)}$$

$$V_n^q = P_n^q + \sum_{i=n+1}^{\infty} \left[P_i^q \left(\prod_{j=n}^{j=i-1} x_j^q \, z_j^q \right) \left(\frac{1+b^q}{1+a} \right)^{(i-n)} \right] \quad \text{.....(5)}$$

$$W_n^q = \sum_{i=n+1}^{\infty} \left[P_i^q \left(\prod_{j=n}^{j=i-1} x_j^q \right) \left(1 - \prod_{j=n}^{j=i-1} t_n^q \right) \left(\prod_{v=n}^{v=i-n} \frac{1+b_v^q}{1+a} \right) \right] \quad \text{.....(6)}$$

Formula (6) can obviously be simplified as (3) and (4).

Restricted Formulation

Not all the statistical data are unfortunately available for putting the above formulae properly into effect: the data relating to each professional class (rate of survival, rate of survival of activity, production and mean consumption) are lacking. Even as a function of age, certain particulars are missing (production and consumption).

Therefore, in the present state of statistical data, we have been compelled to allow the following restricted formulae:

(1) The social and professional categories are restricted to men and women, the age distinction being maintained.
(2) It is assumed that production is independent of age and that each individual shares in the national product proportional to his income.
(3) Consumption is divided equally among all living individuals.
(4) Allowance is made for the free services of housewives by bringing the female activity ratio at each age into line with the male ratio and assuming that the services performed by housewives are equal on an average to the services performed by active women. The national consumption is of course increased accordingly.

There still remains to be fixed the rate of actualization at eight per cent and the rate of increase of consumption and production at three per cent.

In spite of their apparent complexity, the formulae deduced from (4) and (5) can be treated by recurrence and then lead to relatively simple calculations.

We are then in a position to calculate the mean gross and net losses corresponding to an individual of either sex and any age. Table I gives the French figures for 1957.

The next stage consists of balancing the values of this table, allowing for the distribution according to age and sex of the victims of road accidents. The results arrived at are considered later.

D. Affective Factors

Even if a death or an injury were to cause no direct or indirect material loss, it is quite certain that the community would agree to spend certain sums to avoid the moral losses that result.

It is necessary first to examine the nature of these losses.

1.—One of the more obvious psychological consequences of a death is the sorrow caused to the victim's family; this is the *affective injury to the family*.

2.—It seems to be one of the imperative rules of a community to preserve the lives of its members, irrespective of the advantage to be derived, and whether or not the persons concerned have families. In other words, it has to be considered that the nation itself also sustains as a whole a kind of affective injury through the death of one of its members. It may perhaps be thought that this *affective injury of the nation*, for which allowance has to be made, is none other than the sum of the multiple affective injuries of members of the nation, other than close relations. There would then be no difference in concept but only one of degree from the affective injury of families.

3.—It is conventional and legitimate to award a victim a *pretium doloris* by way of compensation for

the suffering he has sustained. If the *pretium doloris* is only allocated, and rightly so, to victims who have not lost their lives, it seems on the other hand legitimate to allow for it for accident prevention, even if the victim dies of his injuries.

4.—Another factor concerns victims who have not been killed, viz. *loss of enjoyment*, which must not be confused with permanent partial incapacity. An injured person whose means of production are lessened sustains, *ipso facto*, a material loss. This is an economic loss, and allowance has already been made for the loss it causes the nation. However, this injured person may also have his ability to enjoy life reduced (typical case: an amateur violinist who loses his left hand). It is legitimate to make provision for this.

5.—The last injury to be mentioned is both most obvious and most easily forgotten—the desire to live on the part of a person whose life is threatened. Indeed, interest is often taken in the balance sheet of past accidents and the question then asked is what the survivors have lost. However, the problem raised concerns future accidents which it is desired to avoid and the possible victim must therefore be included in the community in question. We have suggested terming this injury the '*pretium vivendi*' (price of living).

For a long time, the courts of a number of countries have been accustomed to allow indemnities in compensation for these various injuries and losses (of course with the exception of *pretium vivendi*). These judgments are public, known to the public and it can be admitted that they reflect quite well the opinion of the community as a whole in regard to these problems. However, if an indemnity A is allowed by way of compensation for an injury 'a', is it possible to conclude that the community will agree to spend A at most to avoid 'a'? In the case of material damage the indemnity allowed the victim corresponds to the valuation of the loss sustained. It therefore seems logical to admit that the indemnity allowed as compensation for an affective injury corresponds to a strict monetary assessment of that injury; this assessment should therefore be equal to the sum that it must be agreed to spend to avoid the loss.

An analysis of the judgments of the courts should thus make it possible in each country to obtain an average opinion as regards the sums to be spent to avoid the various affective losses.

It remains to be considered whether the courts take into consideration the fact that certain injuries, such as the affective injury of the family, are inevitable, on the hypothesis that the road accident has merely anticipated the hour. It does not seem, in the present state of knowledge, that the analysis can be carried as far as this end, and in any case, the actual value that would have to be deducted would, on an average, be very slight and doubtless negligible.

Finally, it will also be necessary to value the *affective injury to the nation* and the *pretium vivendi*. The probable amount can be fixed by reference to the other data.

We finally consider as average figure per deceased victim (1957):

Affective injury to family	10,000 NF
Affective injury to nation	5,000 NF
Pretium doloris	1,000 NF
Pretium vivendi	14,000 NF
	30,000 NF

E. Total Estimate for a Human Life

In the particular case of road accidents in France, it is possible to give the following general results, which relate to 1957:

Gross loss of production per individual killed on the roads, not allowing for free services:

$$V = 100{,}000 \text{ NF}$$

Supplement due to allowing for free services

$$V' = 7{,}000 \text{ NF}$$

TABLE I

Production and Consumption losses due to the Death of an Individual of given age[1]

(*Thousands of New Francs*)

Age	Male			Female		
	Production	Consumption	Net Loss	Production	Consumption	Net Loss
1-5	91	91	0	65	93	−28
6-10	118	90	28	85	92	− 7
11-15	152	89	63	109	91	18
16-20	174	87	87	125	89	36
21-25	173	85	88	124	88	36
26-30	166	82	84	120	85	35
31-35	156	79	77	113	83	30
36-40	143	75	68	105	80	25
41-45	127	70	57	94	76	18
46-50	109	64	45	81	71	10
51-55	87	59	28	65	66	− 1
56-60	64	52	12	48	59	−11
61-65	43	46	− 3	32	52	−20
66-70	25	38	−13	19	44	−25
71-75	12	31	−19	9	36	−27
76-80	2	25	−23	1	29	−28
81-85		19	−19		22	−22
86-90		14	−14		16	−16
91-95		11	−11		12	−12
96-100		7	− 7		8	− 8

[1]*For the sake of simplification, the detailed results have been regrouped in age sections of five years. The figures refer to* 1957, *and include free services.*

Loss of consumption per individual killed on the road, not allowing for free services

$$U = 52{,}000 \text{ NF}$$

Supplement due to allowing for free services

$$U' = 15{,}000 \text{ NF}$$

According to formula (1), the purely economic loss would be:

$$p = pV - k(U' + U' - V')$$
$$= 100{,}000\,p - 60{,}000\,k$$

In France, where it seems that full employment is likely to obtain for some time to come, we take $p = 1$. The purely economic loss can therefore be between 40,000 and 100,000 NF.

As regards the affective factors, we have estimated these above at about 30,000 NF. It follows from this that the choice to be made by the government (assuming that it adopts those which we have given above) should logically be between 70,000 and 130,000 NF.

We have stated that our role should be confined to submitting to the executive body data from which it can arrive at its decision. We should therefore be content to ask for arbitration between these two extreme figures. It is rather unlikely, however, that this arbitration would be obtained. We are therefore constrained to attempt it ourselves. It thus seems desirable to select the intermediate figures of 100,000 NF for the following reasons:

(1) This figure represents a balance between gross and net losses, to which the affective injuries are added.

(2) This figure corresponds precisely to the results of the calculation of the gross loss. Now the gross loss has some extremely important characteristics:
   (*a*) It is never negative. The death of any individual can therefore sometimes be regarded as a matter of indifference, but it is never remunerative.
   (*b*) It is fairly easy to calculate according to simple bases and a precise definition. We can therefore be certain of obtaining homogeneous results from one field of activity to another, and this is one of the aims we set ourselves.

More generally it might, when all is said and done, be possible to accept as a simple rule human lives at the value of the gross loss. It will be recalled that by so doing, allowance is made for the affective injuries, but they compensate the deduction of a portion of the future consumption.

Apart from the advantages mentioned above, it should be noted that consumption and the estimate of the affective injury doubtless proceed parallel, and that we remain within the direction of the phenomenon by replacing this by part of the self-consumed loss. However it may be, we shall maintain for 1957 the figure of 100,000 NF. Allowing for the variation in the price level and the volume of production since 1957, the figure to be adopted for 1960 would be about 125,000 NF. Let us recall the exact significance of this: it is at present legitimate to incur any expenditure which for less than 125,000 NF enables a fatal road accident in France to be avoided, assuming that this accident involves no loss other than a human life.

F. Total Estimate per Accident

In actual fact, a fatal accident always involves other losses, for which allowance must also be made. Moreover, a danger point which can be done away with is in fact the scene of a number of material and physical accidents, which must be taken into consideration to define the admissible limit of expenditure. There must therefore be inserted in the balance sheet the material losses and the economic and affective losses corresponding both to the injured and to the dead.

We will not dwell on the details of the calculations and merely give the figures which it seems might be accepted at present in France.

Acceptable expenditure to avoid:

1 purely material accident	500 NF
1 injured person	4,800 NF
1 person killed	125,000 NF
Material damage of a physical accident	2,300 NF

These data can then be combined, allowing for the average number of persons killed and injured per accident.

We thus come to an acceptable outlay to avoid an average physical accident in a built-up area:

Material damage	2,300 NF
Injured persons: 1.19 x 4,800	5,700 NF
Persons killed: 0.044 x 125,000	5,500 NF
Total	13,500 NF

Acceptable outlay to avoid a physical accident of average type outside a built-up area:

Material damage	2,300
Injured persons: 1.42 x 4,800	6,800
Persons killed: 0.121 x 125,000	15,100
Total	24,200 NF

Allowance must of course be made for the fact that the accidents avoided would have occurred in future years, and they should be actualized accordingly in the calculation of the total acceptable expenditure.

It will be noted that in the calculation of the acceptable outlay outside a built-up area, the *pretium mortis* greatly preponderates. This justifies *a posteriori* the large part devoted to its study in the present paper, and it in fact exceeds the scope of road accidents. We thus hope to have made a contribution not only to more effective measures to counter road accidents, but also to a realization of the general problem of the part played by human lives in economic decisions.

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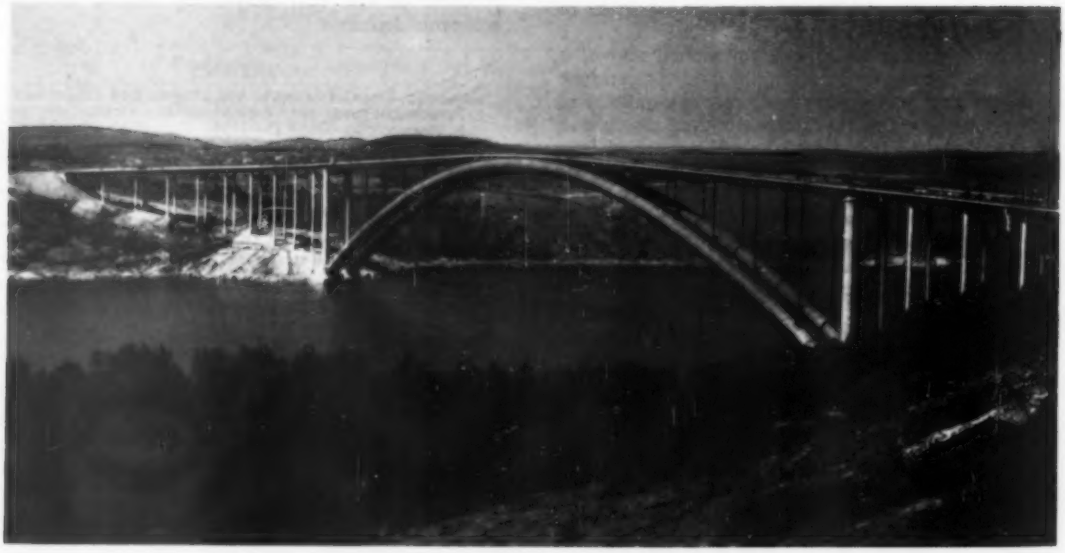
Left: A view of the inside of the new underpass carrying Western Avenue beneath the North Circular Road at Hanger Lane. The lighting of the tunnels was carried out by The General Electric Co. Ltd., and involved glare-reducing covers over the exits.

DEVELOPMENTS

Left: The Stenungsund Bridge, part of the Tjörn project in Sweden, carries the roadway, a cycle track and footpaths from the island of Stenungsön to the mainland. It is a pre-stressed concrete girder construction built by the Dykerhoff and Widman method. Total length of the bridge is 700 *ft., while the centre span measures* 308 *ft.*

Below: A view of the Askeröfjord Bridge, also a part of the Tjörn scheme. Photographs by Skänsa Cementgjuteriët, contractors for the concrete construction.

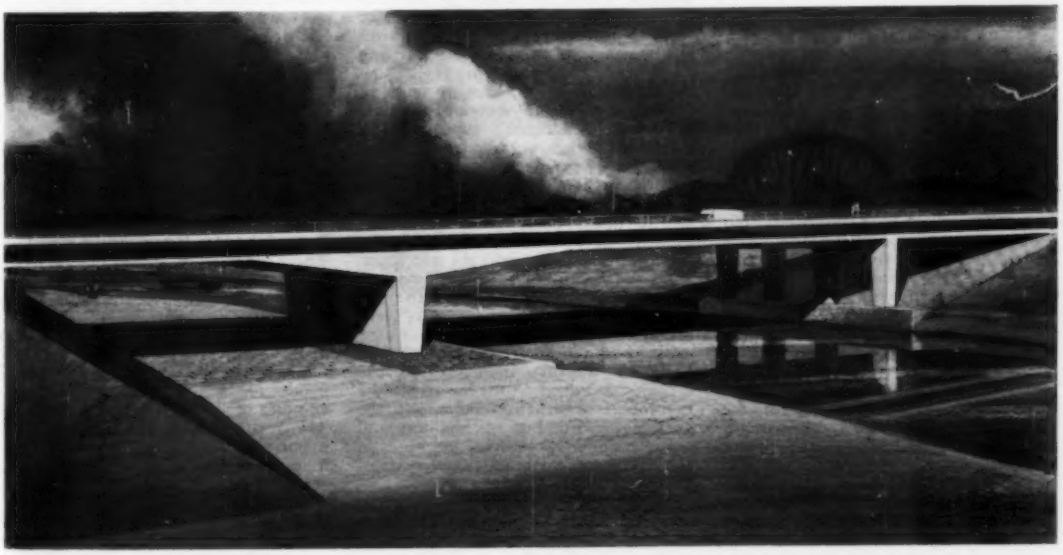


ILLUSTRATED

Right: This concrete fly-over carries Rowley Lane, the road from Boreham Wood to Arkley and Barnet, over the A1. The slip roads connect the fly-over with a newly constructed section of dual carriageways on the Great North Road. Photograph by John Laing & Son Ltd.

Right: An aerial view of the new roundabout recently constructed at Stirling Corner on the Barnet By-Pass. In this photograph, the southern end of the new service road can be seen (bottom right) and the second carriageway, at present under construction, of the Great North Road. Photograph by John Laing & Son Ltd.

Below: Impression of the Medway Bridge, for which the consulting engineers are Scott and Wilson Kirkpatrick and Partners, which will carry the motorway over the River Medway.



ROUNDABOUTS

v

TRAFFIC SIGNALS

AT its meeting on November 17, 1960, the Traffic Engineering Study Group of the Institution of Civil Engineers held an informal discussion on Roundabouts and Traffic Signals. Openers of the discussion were Dr. T. E. H. Williams, Rees Jeffreys Reader in Highway and Traffic Engineering, University of Durham, and Dr. H. C. Smith, Assistant County Engineer and Surveyor, Middlesex County Council. Dr. Williams' prepared paper appears below, followed by that of Mr. Smith together with a brief summary of the discussion which followed their presentation.

THE basic principle of operation of a traffic roundabout is the continuous merging and diverging of cross traffic at approximately equal speeds and acute angles by one-way movement around a central island. The merging and diverging of traffic streams take place within the weaving sections which are distributed around the periphery of the central island.

Weaving Requirements

The geometric layout of the weaving sections, including entrances and exits, together with the percentages and types of weaving traffic in the total flows will control the capacity of any design. Ideally, the carriageway around the central island should at least be wide enough to provide a nearside lane for non-weaving vehicles, an off-side lane for vehicles which have completed their post-entry weaving, and two lanes in the centre for vehicles engaged in weaving. To ensure the continuous and safe weaving of vehicles, their speeds at the entrances to the weaving sections from the approach roads should be of the same order as the speeds of the vehicles which are already within the weaving sections. The radii of curvature of the carriageways, and the shape of the islands at the entrance to the roundabout, should be determined on this basis. Vehicles which have entered a weaving section should be able to complete their weaving movements at a constant speed which is equal or near to that at entry. The distances between adjacent entrances and exits should, therefore, be long enough to ensure that this is feasible, whilst allowing adequate time for the maximum transverse movement possible within the weaving sections.

Limiting Factors

True non-stop weaving will only be possible when the headways between the vehicles in the relevant traffic streams provide gaps of adequate sizes and frequencies to allow safe merging and diverging movements. Discontinuity of flows, due to stop-go movements by the weaving vehicles, occur when adequate gaps are not available for true weaving and/or when the length of weaving section is so small that the paths of vehicles cross at large angles.

The major limiting factor to the capacity of a weaving section is the number of weaving vehicles which can cross the crown line of the carriageway over a given length of time. For the case where the angle of weaving is very small, this number approaches the capacity of a single traffic lane. As the angle of weaving increases, so the capacity decreases. Also, the larger the percentage of weaving traffic, and the greater the number of medium and heavy commercial vehicles and buses in the total flows, the lower the capacity of a weaving section.

Conditions which may justify the construction of a traffic roundabout at an intersection include:

(i) Traffic flows of similar magnitude at the same instant in time on two or more approaches of similar capacity.
(ii) Large volumes of right-turning traffic.
(iii) The number of approaches to the intersection being greater than four.
(iv) Limited widths of approaches, which prohibit the provision of separate lanes for through and turning traffic.
(v) Limited lengths of approaches from neighbouring intersections, which provide inadequate queueing space for vehicles.
(vi) At the ends of high-speed roads, to reduce the speeds of vehicles before they join slower moving traffic on other roads.

Roundabouts: Rural and Urban

There are inherent disadvantages in the roundabout method of controlling traffic movements. In rural areas, where economic considerations are favourable to the construction of roundabouts, the main disadvantage is the enforced reduction in speed of traffic streams on major roads to accommodate lesser volumes of vehicles from minor roads. The recurrence of roundabouts on a major traffic route can be a source of irritation to drivers, and is not necessarily conducive to courteous and safe driving.

In urban areas, where the requirements of pedestrians and buses, and the effects of parked cars and the loading

and unloading of commercial vehicles, lead to the toleration of relatively lower traffic speeds, a roundabout may be suitable. In such areas, with high values of land and buildings, the large area required for an efficient roundabout may make it an extremely expensive proposition. Also, in most cases, the central island is a sterile area which does not easily lend itself to building development at and above ground level. This sterility could be avoided with a very large roundabout, where a multi-storey parking garage could be constructed on the central island, with entrances and exits from the approaches below ground level.

Where the flows are too large for the efficient weaving of vehicles, the problem of priority of right-of-way appears. The use of the central island of the sign 'Give way to traffic from your Right' is one way of attempting to solve this problem. We require more statistical evidence on the effects of this type of sign for a wide variety of sizes of roundabouts and volumes of traffic flows.(*See article on the Middlesbrough experiment in Traffic Engineering & Control, January* 1961.)

An alternative method of controlling the amount of traffic which uses a roundabout at any one time is to install traffic (light) signals at or near the entrances. (*See article on Greenford experiment in Traffic Engineering & Control, September* 1960.)

The smaller the size of roundabout, the more significant is the effect of any one weaving section on the two adjacent weaving sections. The detailed study of the capacities of complete roundabouts in the field is urgently required to supplement the existing information on the capacities of single weaving sections.

Traffic Light Signals
In comparing, from the traffic engineering standpoint, the characteristics of traffic light signals and roundabouts, it is necessary to consider at least four factors:

(*a*) Capacity.
(*b*) Delays.
(*c*) Accidents.
(*d*) Economics.

Factors (*a*), (*b*) and (*c*) are closely interdependent. The basic difference between these two systems of traffic regulations, viz. discontinuous direct movements (signals) versus continuous weaving movements (roundabouts) is reflected in each of these three factors.

Capacity and Delays
In the past few years the detailed studies of saturation flows at signalled intersections which have been carried out by the Road Research Laboratory and other investigators, have resulted in the development of formulae for the capacities of approaches in Great Britain. This is a major step forward in our quest for procedures and methods which apply to British conditions. By means of the Road Research Laboratory formulae, it is possible to compute the optimum length of a signal cycle required to give the minimum delay to all vehicles using an intersection. It is hoped that more field studies will be carried out by engineers to local authorities throughout the country to establish the validity of existing formulae, and to determine the magnitudes of local factors which will reflect the differences in driver reaction times and other characteristics.

The American Highway Capacity Manual introduced the concepts of Possible Capacity and Practical Capacity for signalled intersections. When the traffic flows reach the level of possible capacity every green period is fully used and the queues on the approaches continuously increase in length. At the level of practical capacity, most drivers are able to clear the intersection without waiting for more than one signal cycle. The latter level of flows gives a criteria for the design of signal cycles.

Accidents
In comparing accident records for intersections with traffic lights against those for roundabouts, it is essential to appreciate that police records alone may not show the true state of affairs. This is because the police are usually informed of accidents involving personal injuries and severe property damage, and the greater risk of such accidents exists with traffic lights, due to the greater range of speeds and the greater angles of intersection of vehicle paths.

With roundabouts, the slower speeds and lower angles of intersection of vehicle paths, the types of accident most likely to occur usually result in relatively minor property damage, and without personal injuries. This would only require the usual exchange of addresses by the drivers concerned, and all details would be subsequently given to their insurance companies. In traffic engineering, records of minor accidents can be an invaluable guide to the physical factors which are the most frequent causes of accidents at intersections.

Economics
In addition to comparing the cost of land required for a roundabout with the capital cost of signals, and also the maintenance costs for the two facilities, it is advisable to compute the annual rate of economic return as developed by Charlesworth and Paisley. This economic index takes account of the degrees of benefit to traffic flows from a change in method of traffic regulation.

Co-ordination and Progression
In urban areas and central business districts in particular, where intersections are numerous and present day traffic flows are frequently at possible capacity level, some system of co-ordination of adjacent signals is clearly required to ensure that carriageway spaces are available on the exits from intersections at the appropriate times. The type of co-ordination or progression suitable for a particular group of intersections can only be determined after a comprehensive analysis of traffic volumes and speeds. The engineers responsible for such studies should also be thoroughly acquainted with the facilities available through automatic traffic signal controllers.

In the ultimate limit of progression, all traffic signals in the central business district may be linked to a master controller which could automatically choose the appropriate pre-selected programme of signal cycles for a given pattern and magnitude of traffic flows.

Conclusions
The choice of a roundabout or traffic signals as a means of regulating traffic flows at an intersection must be related to the conditions at that intersection. Each problem must be considered on its own merits, but it should not be divorced from the problems at adjacent intersections. Traffic volumes, speeds and delays form the basic data which is required for capacity computations, economic analysis and the design of co-ordinated signal systems.

ACCIDENT COMPARISONS

H. C. Smith, Assistant County Engineer and Surveyor Middlesex County Council, in his prepared paper stated:

THE basic requirements of a road junction are to provide adequate safety for all users of the junction, and satisfactory traffic flow, having due regard to economy.

A comparison has been made of two treatments adopted for junctions and relates to twenty-four junctions within the County of Middlesex, 12 automatic signal controlled and 12 roundabouts, the junctions being of similar four-way cross roads on Trunk, Class I, Class II and Class III roads, and of relatively equivalent traffic flows. Fig. 1 graphically shows the accident record and the average traffic flow at these twenty-four junctions. Table I shows the traffic volume, and Table II the number of personal injury accidents.

From Table II it will be noted that fewer personal injury accidents occurred at roundabouts than at traffic light controlled junctions and, of the road users involved during this nine-year period, it will be noted that 127 pedestrians were involved at the traffic light controlled junctions, compared with a maximum of 48 at the roundabouts. These 48 include the pedestrian accidents at Hendon Central roundabout where 16 pedestrians were injured (one-third of the total pedestrians injured on roundabout junctions). The figures show that for the nine year period approximately twice as many incidents occur at traffic light controlled junctions as at roundabouts for the same flow of vehicles in the same period of time.

It is of interest to note that the record of accidents at Brent Street junction

with the North Circular Road, for the three years prior to the removal of the roundabout, was two in 1951, three in 1952, two in 1953, a total of seven, and that, after the installation of traffic lights, the accident record was seven in 1955, seven in 1956 and eight in 1957, a total of 22, and in the year 1958, 11 rising in 1959 to 13 personal injury accidents.

Similarly, the accident rate at Neasden Road Junction with North Circular Road has increased since the traffic lights were substituted for the roundabout. The incidence of darkness on accidents is similar for each type, 33.63 per cent occurring during darkness on the 12 traffic light controlled junctions and 34.82 per cent on the 12 roundabouts.

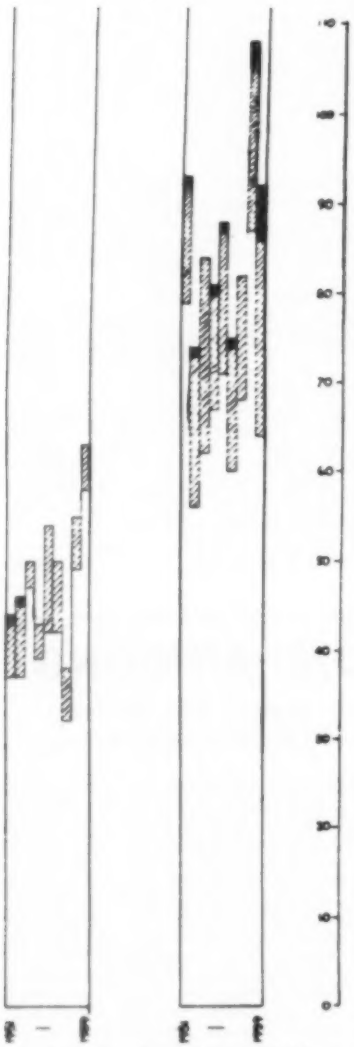


Fig. 1. Comparison of personal injury accidents, 1951 to 1959, at 24 junctions, showing those at 12 roundabouts on left and 12 automatic signal controlled intersections on right.

TABLE I

Traffic flow—1954 Census—No. of Motor Vehicles per hour

Peak Hour	*On the 12 A.T.S. Junctions*	*On the 12 Roundabouts*
Total number entering the 12 junctions	25,340	26,090
Range of Flows		
Average No. per junction	2,111	2,174
Maximum Flow into a junction	3,900	3,300
Minimum Flow into a junction	710	1,100

Signal Control

An automatic traffic light signal is normally so arranged that while the green light gives freedom of passage in either direction along one road, the cross road traffic is stopped by the red light, and the change of the light signal is regulated by the traffic demands of each road. When there is a demand from the cross traffic the signal lights change first to amber on all the roads into the junction, and then to green on the crossroad with the red light coming into operation on the other road. The delay in the change of the light signal being regulated by the time necessary for the various traffic streams to move out of the junction, usually the right turning traffic having to wait until the opposing stream has stopped, or there is a sufficient gap through which to cross. To enable this turning traffic to clear the junction, the delay has sometimes to be increased by the red signal being displayed on all the roads. Similarly, it is sometimes necessary for all-red signals to be displayed on all roads to provide for pedestrian cross movement at very busy junctions. The demand is registered by the vehicle passing over a pad situated in the carriageway, some 90 ft. to 120 ft. from the signal, and when there are frequent vehicles on both roads the lights can change in front of an approaching driver between the time he crosses the pad and before he reaches the stop line at the signal, in which case he may be unable to obey a signal. There is always the possibility of two drivers, one on the main and one on the crossroad, approaching a signal at the time of its change, both driving rather too fast and both 'jumping the lights' (each driver need only be fractionally wrong in time), An accident follows, and a collision in these conditions is generally serious.

Roundabouts

In the case of a roundabout, because of the physical conditions traffic has to slow down, permitting movement into the appropriate traffic lane, with no right turning against the opposing stream. Generally, the roundabout permits traffic to pass through a junction satisfactorily and is more acceptable to drivers generally than traffic light controlled junctions. It is unusual for motorists to use side streets to avoid roundabouts, but there are many cases where drivers use side streets and other deviations to avoid a traffic light controlled junction, in some cases even to making a right turn across the opposing stream (a very serious source of danger) causing accidents away from the junction. Automatic traffic signal controlled junctions create greater delay for traffic than roundabouts because of the need to obey signals.

Economics

It is not sufficient to compare only the initial capital outlay of alternative schemes: such comparison should take into account the potential saving in the national expenditure.

TABLE II

Personal Injury Accidents during the nine years ending December, 1959

Degree of Injury	*No. at the 12 Traffic Signal Controlled Junctions*			*No. on the 12 Roundabouts*		
	1951/59	1958	1959	1951/59	1958	1959
Fatal	14	3	6	2 (1951/52)	—	—
Serious	148	18	22	60	6	5
Slight	614	87	64	383	49	58
TOTAL	776	108	92	445	55	63
Average per year ...	86.2	108	92	49.4	55	63
Average per junction ...	7.2	9	7.7	4.1	4.6	5.25

Users involved	*No.*	*Range at any site Max.*	*Min.*	*% of Total*	*No.*	*Range at any site Max.*	*Min.*	*% of Total*
Pedestrians	127	29	3	16.4	48	16	—	10.7
Pedal Cyclists	190	28	2	24.5	98	22	1	21.9
Motor Vehicles	459	82	13	59.1	299	39	10	67.4
TOTAL	776	121	40	100	445	63	17	100

The Road Research Laboratory estimates the average cost of a personal injury accident at the 1957 values to be £540, the cost of delays varying from 5s. 2d. per vehicle hour, to 9s. 9d. per vehicle hour in congested areas, and the cost of vehicle operation is 4.2d. per vehicle mile.

The initial cost of constructing a roundabout in an urban area is probably in the neighbourhood of £20,000, as compared with £2,500 for the installation of traffic lights, plus the annual cost of maintenance of £110 per annum for traffic lights.

It will be noted from the accident figures that on average there are seven accidents per year at traffic light junctions as compared with four per year for roundabouts, i.e. an additional three accidents per year, equivalent to a cost of £1,620 p.a. per junction. The cost of delays per traffic light junction based on the twelve sites considered and at the rate of 7s. 6d. per vehicle hour ranges between £1,700 and £13,100 p.a. with an average of £6,210 per junction.

The additional distance travelled when using a roundabout is approximately 20 yards per vehicle and the cost, at the rate of 4.2d. per vehicle mile, ranges between £380 and £2,120 for the twelve sites considered, with an average per roundabout p.a. of £1,180 per junction.

ANNUAL COST—AUTOMATIC TRAFFIC SIGNALS

	£
Interest on £2,500 at 5% per annum	125
Cost of 7 accidents per year	3,780
Extra cost of maintenance ...	110
Cost of delays	6,210
	10,225

ANNUAL COST—ROUNDABOUTS

	£
Interest on £20,000 at 5% per annum	1,000
Cost of 4 accidents per year	2,160
Extra cost of travelling time	1,180
	4,340

Conclusion

From this comparison I would suggest that where there is room at a junction to construct a roundabout then it is to be preferred to traffic lights. Obviously, when traffic reaches a certain volume no one level crossing will be adequate for control. There are occasions, however, where the super-imposing of traffic lights on a roundabout layout could be of material assistance in traffic flow as an intermediate measure before the construction of a grade separation form of junction.

DISCUSSION

A contributor to the discussion that followed, speaking of American experience in land use planning and traffic control, said much of its success was due to the fact that for main highways the principle had been adopted that no one lane of traffic must intersect or conflict with another. That led to such enormous interchanges as those at Los Angeles and San Francisco, which were frightening, but which represented the logical development of the principle. On major highways in this country that principle had to some extent been adopted, because there were some dual carriageways and high-speed roads and for these he regarded roundabouts as quite unsuitable. It was not possible to exchange them for lights, as had been proposed, but the more the principles of hydraulic flow were applied to these major highways the better. The hydraulic engineer would put a valve of some sort on a side line, but on an important pipeline he would not do so, and he certainly would not have a large obstacle blocking the pipe and allow the water to flow round that. For major highways some other method must be developed, such as two-level interchanges. It was an antithesis to develop a high-speed road and then at intervals put in a blockage of that kind.

Research Results

Another speaker commented on the work of the Road Research Laboratory as it affected roundabouts and traffic signals. The results of several before and after studies had shown that when roundabouts had replaced ordinary crossroads, uncontrolled, or controlled only by 'Halt' or 'Slow' signs, there had been a 60 per cent reduction in accidents. When traffic signals had replaced a similar type of control, or no control at all, the reduction in accidents had been 40 per cent. Where traffic signals had been replaced by roundabouts, or *vice versa*, figures for all the sites grouped together showed that roundabouts were safer so far as accidents were concerned by about 30 per cent.

Generally it might be said that there was a place for the traffic signal and a place where it was obvious that roundabouts were better, but this was not always the case and in many locations it was difficult to decide whether traffic signals would be better than a roundabout or *vice versa*, and that, of course, had been how the war between traffic signals and roundabouts began. There was only one real approach—to treat it as an economic problem.

The speaker said he had done some calculations on a particular example of delay at roundabouts and traffic lights. For a traffic signal he had taken a 60-second cycle with 25 seconds green and typical saturation flows, and had assumed for two hours operation at 90 per cent capacity, and for two further hours 80 per cent, and for 10 hours 60 per cent. From the Road Research Laboratory formulae he worked out the delay to be 19 seconds at a typical traffic signal intersection. Similarly, they had studied roundabouts and obtained daily flows. Flows had been plotted for several roundabouts and a mean curve found. From that curve the speaker had again worked out delays at 90 per cent, 80 per cent, and 60 per cent, and had found the average delay, in comparable conditions for traffic signals to be eight seconds. That eight seconds did not take account of the extra distance travelled or of the slowing down. The Road Research Laboratory formula for traffic signals included the slowing down and speeding up as well as the delay in queueing; but the figure for roundabouts gave only the queueing delay and the juggling for position, which obviously resulted in a certain delay. He had then assumed that the speed of the traffic was 30 m.p.h. on the road and that it slowed to 15 m.p.h. to negotiate the roundabout, travelled round the roundabout at 15 m.p.h. and then accelerated to 30 m.p.h. It had been found that 15 m.p.h. was about the speed through a roundabout. This gave a further delay, over and above the signal case, of seven seconds. In the example taken, therefore, there was a figure of 19 seconds for the traffic signal and of $7 + 8 = 15$ seconds for the roundabout, or in other words a net saving in delay for the roundabout of four seconds. Obviously more information was needed on delays at roundabouts and it was hoped to obtain it.

From the results on some six different roundabouts it had been found that in practice the capacity of a roundabout was about 85 per cent of the formula produced by the Laboratory on the basis of the Northolt tests. This work was still in a preliminary stage and had not yet been published. More information would be required before a final figure could be given, but it looked as though the figure should be about 85 per cent. It had been found that in certain cases the roundabout was in danger of locking when it was over 80 per cent of its measured capacity, which in itself was about 85 per cent of the Northolt test figure, so that locking might take place at any value from about 80 per cent upwards, although 100 per cent could be reached without locking, depending entirely on driver behaviour.

If delay was plotted against flow the curve turned back on itself, so that the roundabout was unstable in the last 20 per cent of its capacity. This was a factor which at first sight seemed to be against roundabouts, but it had been found that when signals were installed on the approaches this improved the capacity and enabled the roundabout to be used to its full capacity with very little danger of locking. There was still, however, a slight danger of locking, and that was being looked into to see when the roundabout got into a certain stage of congestion.

Priority from the Right

The results of the experiments on signal control at roundabouts showed that the capacity was between zero and 10 per cent greater than with police control, and was more consistent. It was about 40 per cent greater than the stable capacity, i.e. the capacity when the danger of locking was negligible. The information so obtained on roundabouts obviously favoured the roundabout and meant that it was possible to extend its life.

Report of the paper and discussion on The Work of the Graduate School in Highway Engineering, University of Birmingham given by F. D. Hobbs, will be published in the March issue.

SCIENTIFIC APPROACH TO URBAN TRAFFIC PROBLEMS

by W. Fisher Cassie, Ph.D., M.S., F.R.S.E., M.I.C.E., M.I.Struct.E.
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THIS paper, presented to the All-Party Roads Study Group of the House of Commons on Tuesday, December 13, 1960, considers the problem of the simultaneous consideration of the problems of planning, architecture and traffic. This subject is to be discussed at an International Symposium, Newcastle upon Tyne, April 10-14, 1961. The Symposium will be technical and open to all those professionally or technically interested, and will be addressed by speakers from several countries in Europe and from the United States. Details were published in the January issue of this Journal.

THE urban traffic problem as it confronts us today can perhaps be defined as follows:

To produce conditions in which a free flow of motor traffic can be achieved in the central business and cultural areas of cities, and in the surrounding residential areas, without loss of the character of the city and if possible with its improvement. Planning and architectural designs for the changing city should not be subservient to but rather concurrent with traffic planning. At the same time, forcible restrictions on the movement of vehicles should be at a minimum so that the car driver who wishes to do business in the centre of the city is not forcibly prevented from entering the business area.

The conditions laid down in the definition of the problem indicate that town planning and architecture must be considered at the same time as the traffic flow. The pattern of city development influences the range and intensity of traffic generation and attraction, and, in more detail, the type of building erected within that pattern controls the local generation of traffic. To erect large office buildings without regard to the traffic facilities likely to be available to serve the buildings, is to treat the problem in a subjective and unscientific manner, and to invite intensifying congestion.

The type of city developed in the United States, particularly in California, has been produced by allowing the traffic factor to take pre-eminence over the other two. Neither town planning nor the demands of new architecture has been sufficiently understood. The Californian cities are based on mobility, but central character is being lost to the

thin sporadic development, which stretches for many miles, carried on a flood of motor vehicles. To allow the car and the property agent to dictate the type of city development of the future would, in this small country, be entirely ruinous. Unless, however, a more coherent understanding of how the triple needs of planning, architecture and highway engineering are to be interwoven, we shall not extricate ourselves from the present impasse.

Recording the Facts

If the traffic problem is to be studied scientifically the first necessity is a regular collection of facts. Much greater sums must be spent on continuous observation and recording of the characteristics of traffic flows in the streets of our cities. Facts about the details of the vehicles themselves, their reaction to certain road surfaces, the effects of special lighting conditions,the improvement obtained by new types of brake or other mechanical devices can be recorded by experiment, which is so much a part of the scientific method. The Road Research Laboratory's new proving track at Crowthorne offers a large outdoor laboratory where such experimental work can be carried out. This proving track is the physical expression of the policy of controlled experimentation as a method of obtaining the facts about some of the problems of highways and traffic.

In general, however, the important facts must be built up from observed flows of traffic in existing urban conditions. Part of the skill of the observer of traffic conditions lies in determining not only that certain conditions exist, but also why these conditions come to pass and how they vary with time. This requires the questioning of drivers of vehicles, or of people in their own homes, so that sample conditions for every type of residential property and every type of vehicle can be worked out. Some of the most illuminating facts defining the characteristics of traffic conditions have been determined from origin and destination surveys. These have formed the basis of the fundamental principles which are now recognized to operate in cities in all the western countries which have an urban traffic problem.

Value of Statistical Methods

Between observed facts and their trends are the theories or laws governing them, and the link is made by mathematical statistics. By statistical method, not only can the trend of facts be determined, but their mutual relevance can be established. Care must be taken in recording facts to ensure that the sample observation has, in fact, the same characteristics as the total number of facts which could have been observed if that had been physically possible. Even a close correlation between two sets of facts cannot be accepted as showing their mutual dependence. Mathematical statistics prevent the observer from falling into errors of judgment when dealing with the random flow represented by traffic.

Any controls aimed at reducing the effect of traffic congestion should, for example, be directed by the simple but important conception that the behaviour of the individual driver is of the utmost importance. Appeals to the driver to restrict the use of his car, in some way which is not palatable to him, are likely to be disregarded. It has been shown that attempts to encourage drivers to act voluntarily in such a way as to improve conditions for the good of the community at large, at the expense of their own convenience, are certain to fail. As Sir Alker Tripp averred many years ago, it should rather be made easier for the driver to act in the way the traffic engineer considers best than to act in any other manner. Only by this type of control can results be achieved.

If we accept the fact, observed in many cities, that we are planning not only for a numerical agglomeration of individual and inanimate units, but also for one human driver, the way is open to the elucidation of further principles. The second observed fact is that unless the driver is allowed to enter the central business district of the city, that district begins to decay and decentralization of retail business and commerce takes place. This has been shown time and again in cities where traffic density is higher than in this country. In Boston, Massachusetts, for example, the rateable value of the central area dropped by 34 per cent before adequate provision was made for traffic flow. Some argue that decentralization is not an unmitagated evil, and if we think only of retail business this may well be so. The commercial decay of a large city, however, might well also mean the decay of cultural activities which only a large city can support. It can be taken as axiomatic, therefore, that the central business area must be preserved as a working unity. Those entering this area come either to do business or to work daily for the business concerns of the area.

Incompatibles and Conflicts

With our present city street systems we are faced with incompatibles. All vehicles which have business in the centre of the city cannot travel easily all the way on streets originally built not as arteries but as business channels. Such travel combined with the stopping of cars for business purposes causes congestion and immense delay, so that no individual attains his objective efficiently. A further complication arises from the fact, so often observed, that the mingling of street users capable of widely varying velocities and of widely varying accelerations, causes danger and accidents.

Detailed examination of the behaviour of individual units of traffic by means of origin and destination surveys has shown that in large cities the traffic seen in the streets is nearly all self-generated. Only a minor proportion of traffic in city centres has any business outside the confines of the city, or even outside the confines of the central area. The facts examined scientifically, and without prejudice, show quite clearly that for any large city there is no hope of diverting more than a very small proportion of traffic by providing attractive routes outside the central areas. There is no case, for example, for a by-pass round the whole city, for the proportion of through traffic is negligible. Similarly, any attractive peripheral route at a mile or two radius from the centre, although more likely to be used by traffic, is not a solution to the problem of congestion within the business areas.

Lessons from America

In trying to lay down principles, from the facts which have been observed, it is well to remember that the behaviour of drivers in modern cars in similar situations is unaffected by the country in which the driver finds himself. Countries such as the U.S.A., therefore, where the vehicle/population ratio is higher than in this country, form large-scale laboratories in which experiments have taken place. The results of these experiments can be seen, and have been widely discussed in technical journals. Conclusions can be drawn with confidence from these experiments as to the effectiveness of proposed controls and constructions in this country. American conditions represent a glimpse into the future so far as this country is concerned.

Taking all the facts into consideration, and combining these with the successes and mistakes of the American engineers under traffic intensities which we have not yet reached, two principles emerge. The first is that the life of the city depends, these days, on the presence of the motor vehicle and, secondly, that the major portion of the short journeys each vehicle makes should be carried out on special roads for motor vehicles only—motorways in cities, that is urban motorways. Any other attempted solution has been shown to be merely palliative and quite defenceless against a rapidly increasing motor vehicle population.

Much of the difficulty we have encountered in recent years has been due to the attempts so often made to cure local conditions of congestion by immediately obvious and local methods. Such *ad hoc* solutions usually result in increasing congestion and delay in adjacent areas. The facts observed in this country and abroad have shown that, without any doubt, a complete solution can be obtained only by the establishment of principles which include in their ambit the requirements of architecture, town planning and highway engineering. Radical changes in detail in the city must be approved if the general character is to be maintained, but these detailed changes must not be confused with *ad hoc* local alterations.

Shape of the City

If the principles referred to are finally to be applied the result will be what is so often termed 'The City of the Future'. The important difference between this projected city and the confusion of the present day city will lie in the provision of special facilities for the motor vehicle. These special facilities consist of two types of construction: the first is the urban motorway which is already well known abroad as a sunken channel within the city, carrying an uninterrupted and fast flow of motor vehicles to points where short distributive journeys bring the drivers to their destinations. This criterion of a short journey on city streets means that the motorways should not be distant from the points of highest congestion. Remembering

that the city itself generates its own traffic, urban motorways must attract vehicles even on short journeys. The conclusion from this deduction is that urban motorways must pass close to and through the business districts of any large city. Instead of the geometrical layout of ring roads and radials, so beloved of the planner in the last forty years, the present day conception must be of distributive loops of motorways crossing each other at a few important intersections but being otherwise independent. The passage of a vehicle round a business district should be imagined in the form of a parabola or ellipse forming the kind of track shown by a satellite in orbit. At any point in this curving track coming in from outside the city, passing through or very close to the business district, and passing out again on another radial, the driver can leave the motorway by a slip road for a short journey to his destination.

Motorway Economy

It should be remembered that the mileage of urban motorways required need not be great. It has been shown, in the most advanced cities, that 5 per cent of the street mileage when converted to motorway standards carries 50 per cent of the traffic. This causes an immense diminution in street congestion.

The second of the new structures envisaged in this city of the future is the parking garage made available for those who cannot bring their vehicle to rest within the confines of the business premises they are visiting. Since the greatest proportion of the traffic lies in the motorway it is logical to envisage that the parking garages will be erected at the edge of these motorways, or between the motorways and the areas of greatest present day congestion.

With this picture in mind, one need not imagine any vast alterations to the character of the city, but certain corollaries follow this plan. The provision of urban motorways linked to the rural motorway system encourages the spread of residential development—something which is to be avoided at all costs in this small country although acceptable in Southern California where the vast playgrounds of the sierras and the deserts provide a safety valve not available here. The corollary then is that our advanced land-use planning, so far ahead of that in the United States, should be strengthened if the urban motorway is to solve our problem. Green belts, which are the envy of the Californian administrator and engineer, must not be whittled away, and development of residential areas should be on well planned lines. We have in our land-use planning an advantage of great value.

Need for Public Transport

Despite the construction of urban motorways it will still be essential to maintain a public transport system of increasing efficiency and minimum cost to the passenger. This principle is now being recognized in the United States, where in past years public transport systems have been killed by the uncontrolled use of the motor car. Immense efforts are being made by the Americans to set up or resurrect their fading or extinct mass transit systems. So valuable is an efficient public transport system in the relief of congestion that it could well be run at a financial loss and still provide a measurable benefit to the community. The major public transport routes would, in this country, be either underground railways, or bus routes on the new urban motorways. The latter might be fed by subsidiary public transport routes on city streets when relieved of much of their congestion, but large buses on city streets may well be replaced in time by special routes or vehicles. They should not be looked upon as permanent.

Segregation Essential

The third corollary is that one might take the process of segregation a further step ahead. Having segregated fast transport from that merely distributing itself to its final stopping place, we could also segregate different types of road users. The most pressing need is the segregation of the pedestrian from the motor vehicle and in all countries, including the United Kingdom, pedestrian precincts are being planned and erected. In this country, unfortunately, this is being done without the preliminary of urban motorway construction. In the United States, these precincts fit into the urban planning more logically since there is at least a skeleton of fast motor routes. It is interesting to note that the Americans are using the old word 'mall' for their pedestrian precincts. There is no doubt that in all western countries retailers are at last moving away from the idea that heavy traffic passing the door means better business.

I have tried in these remarks to show that the obsession with detailed alterations and a tendency to exaggerate an amenable problem, such as parking, into a major dilemma—which so characterizes discussion on the traffic problem—is a method of attack which will not lead to better conditions. No amount of installation of pedestrian crossings, traffic lights, pink zones, blue zones (as in Paris), no waiting restrictions and other palliatives will be of effect until the basic principles of scientific alleviation of the traffic problem are accepted.

These principles based on incontrovertible facts point to the following conclusions:

(*a*) The motor vehicle is essential to the life of the centre of a modern city: it cannot be banned, but it cannot use the present routes exclusively.

(*b*) The city streets cannot be used as main arteries, even when transformed into 'clearways' without congestion and should be used merely for distribution of vehicles over distances as short as can be arranged.

(*c*) The major flow of traffic should be fast and uninterrupted even for the few miles which represent the average journey of a city motor vehicle. This means the provision of urban motorways. The sunken type should be chosen, for such motorways do not visibly flaunt their presence, and the slip roads readily give the acceleration and deceleration required for safety.

(*d*) A very efficient public transport system will be vital to the efficient operation of the city of the future. In this country we are ahead in the provision of such public transport systems and this advantage must not be allowed to die under the influence of rising fares which, in turn, cause more congestion.

(*e*) We are also further advanced than other countries in land-use planning, and the footholds gained here must be retained at all costs. If by reason of the pressure of vested interests green belts are penetrated, the explosive development of thin residential areas will bring disaster.

(*f*) Segregation of vehicles and pedestrians, by the construction of pedestrian malls, will give the final touch to a city in which freedom of movement for large volumes of traffic is allied with freedom of space for the cultural and commercial activities of the city centres.

next month

Traffic Control—Sydney Harbour Bridge
R. R. COWL, Department of Main Roads, New South Wales

Value of Channelization, *WILLIAM L. CARSON*
Traffic Engineering Department, American Automobile Association

Radials or Ring Roads? *R. M. HARE*
Fellow of Balliol College, Oxford

Saturation Flow at Signal Controlled Intersections, *BRIAN HELM, Consulting Traffic Engineer*

Courses in Traffic Engineering, *London University*

Profile of Granville Berry, *City Engineer, Coventry*

Traffic Engineering Bibliography

5. ACCELERATION, DECELERATION and FUEL CONSUMPTION

By B. D. RICHARDSON

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THE braking performance of a vehicle is generally considered to be defined by the rate of deceleration achieved in an emergency stop. This rate of deceleration is affected by three main factors:

(*a*) the design and condition of the braking system,
(*b*) the skill and physical limitations of the driver,
(*c*) the friction developed between the tyres and the road surface,

Each of these factors may, in varying situations, predominate.

This rate of deceleration under emergency conditions, when coupled with such other factors as reaction time, is of concern to the traffic engineer in considering stopping sight distances; but also of importance are deceleration rates under other conditions demanding less violent action. An example is the rate of deceleration in slowing down to enter a side road which can be used in the determination of the length of a deceleration lane. A further example is the consideration of the traffic stability conditions in a city street. It would be unreasonable to expect to travel a length of street under city centre conditions without using brakes, but an excessive use of braking manoeuvres involving a rate of deceleration in excess of say 5′/sec.^{2} would indicate a measure of instability the cause of which—a badly sited pedestrian refuge for instance—could be investigated. In many ways, therefore, deceleration rates concern the traffic engineer and a decelerometer provides a suitable method of measuring them under differing road conditions.

Fig. 1. Pendulum Type Decelerometer.

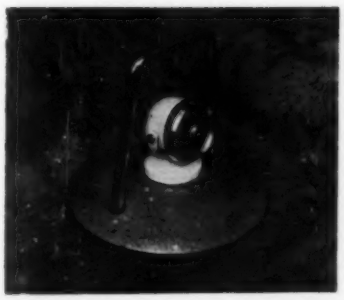

Fig. 2. Decelerometer fixed to heavy base and carried on the floor of a car.

Decelerometers

There is a wide variety of decelerometers available. One type consists of a U-tube arranged so that the vertical plane containing the limbs of the tube also contains the longitudinal axis of the vehicle. Deceleration results in the transfer of liquid from one limb to the other which can be measured. A second type has three hollow tubes each containing a ball bearing. Deceleration causes the ball to move up the tube and each tube is so arranged that at different rates of retardation the tubes will tilt and bring up a marker. The pendulum type of decelerometer is illustrated in Fig. 1. The pendulum is arranged to swing in the fore and aft direction of the vehicle and is damped by a special blend of silicone fluids which is viscostatic over the range of temperatures likely to be encountered. Movement of the pendulum is transferred to an indicator needle by a precision gear train. A 'tell-tale' needle is moved into position by the main indicator needle where it records the maximum reading after which it can be zeroed manually by turning the knob in the centre of the dial. Since the pendulum can move either forward or backward, acceleration as well as deceleration rates can be measured. In the absence of both acceleration and deceleration, the meter will indicate the percentage gradient being travelled by the vehicle.

In operation the meter is fixed to a heavy metal base (Fig. 2) or it can be attached to the windscreen or facia board by means of a suction pad (Fig. 3). It is zeroed by placing the vehicle on level ground and tilting the face backward or forward until the indicator needle reads zero. Retardation during operation of the vehicle is measured by the needle moving anti-clockwise round the dial leaving the 'tell-tale' recording the maximum rate in terms of percentage 'g' (32.2 ft./sec.^{2}). Conversely, maximum acceleration rates are measured by the 'tell-tale' being moved clockwise round the dial.

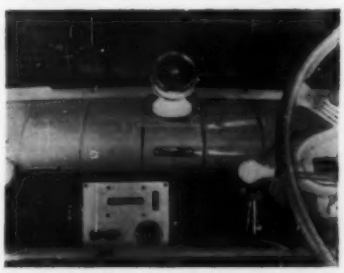

Fig. 3. Decelerometer fixed to facia panel by a suction pad. Fuel Meter Recorder beneath facia panel.

Fig. 4. Recording Type Decelerometer.

The main source of inaccuracy arises when recording the maximum rate of deceleration under emergency braking conditions. The sudden application of brakes causes a rapid load transfer to the front wheels. The resulting vehicle tilt may amount to 3° or more and make the observed rate of deceleration some 5 per cent higher than the actual rate.

A disadvantage of this type of meter is the difficulty of observing varying rates of deceleration or acceleration when these occur during any particular manoeuvre. A type of recording decelerometer which overcomes this difficulty is illustrated in Fig. 4. A mass is attached to the ends of a pair of cantilever arms, movement of which, due to acceleration or deceleration forces, causes a proportional movement of the arms which is recorded on a celluloid film. The film moves at a steady speed and also records intervals of time in 1/10 second units. The deflections are small and the film needs to be enlarged before evaluation but the resulting deceleration or acceleration time curve provides an accurate record of the measured rates for the duration of the manoeuvre being investigated.

TABLE I

Class of Vehicle	*Assignment Speed m.p.h.*	*% change in fuel consumption*
Small cars	50	+ 3
Large cars	50	—16
Light commercial vehicles	45	+ 2
Medium commercial vehicles:		
Petrol	40	+ 4
Diesel	40	— 1
Heavy commercial vehicles:		
Small Diesels	35	— 8
Large Diesels	35	—27
Petrol vehicles	35	— 4

+ indicates an increase
— indicates a decrease

Change in fuel consumption per mile on transfer to Motorway adapted from Road Research Technical Paper Number 46—The London-Birmingham Motorway—tables 23 and 27

The foregoing has been mainly concerned with deceleration but, as implied, the same considerations apply to the measurement of acceleration rates. A knowledge of such rates for a variety of manoeuvres is necessary in the consideration of acceleration lane length, passing sight distances and other design features.

A further interesting aspect is the measurement of the lateral ratio incurred when a vehicle rounds a curve. The centrifugal force acting on the vehicle in a superelevated curve can be resolved into a force normal to the road surface and a lateral force parallel to the road surface. The ratio of the lateral force to the weight of the vehicle is termed the lateral ratio and, within the limits of normal operation, produces the sensation of cornering. It can be measured by mounting the meter transversely in the vehicle instead of fore and aft. Leeming and Black in a series of papers, culminating in 'Road Curvature and Superelevation: A Final Report on Experiments on Comfort and Driving Practice', Journal Inst. Mun. Eng. Vol. LXXVI No. 8, February 1950, have described the use of an accelerometer in investigating aspects of cornering and show how the lateral ratio forms a basis in considering such design features as minimum radius, superelevation and transition curves.

Fuel Consumption

Assignment curves, as previously mentioned in this series of articles, are used to estimate the amount of traffic which will transfer from existing routes to a new or improved route. Usually the basis for an assignment curve is the amount of time saved or lost as a result of transferring to the new facility. Another consideration in assignment is the saving or loss of fuel due both to difference in mileage covered and to the change in operating conditions, and fuel consumption figures should be used in interpreting an assignment curve based on time savings alone. (See Table I).

Further, in arriving at a cost/benefit ratio to justify an improvement, particularly in an urban area, a major item on the benefit side will be the saving in fuel due to a reduction in delay and congestion. This can be seen when it is realized that a typical middle powered family saloon having an average petrol consumption of 30 miles per gallon can, in congested conditions, use petrol at the rate of eight miles to the gallon.

Fuel Meters

A meter suitable for measuring fuel consumption under road conditions is illustrated in Fig. 5. The meter is inserted in the fuel line of the vehicle between the fuel pump and the carburettor. It consists of two measuring chambers separated by a moving diaphragm. Fuel from the pump passes into one or other of the chambers depending upon the position of a slide valve. When the chamber is filled the movement of the diaphragm completes an electrical circuit which, by way of a solenoid, alters the position of the slide valve. This allows the chamber to empty—the fuel passing on to the carburettor—and the other chamber to fill and repeat the process. The closing

Fig. 5. Fuel Meter.

of the electrical circuit also passes an impulse to the recorder (Fig. 3) which is carried inside the vehicle and this impulse moves the counter of the recorder by one figure. Each chamber measures 0.0005 gallons and thus each unit moved on the counter indicates the passage of 1/2,000 part of a gallon of fuel.

In use, the vehicle fitted with the meter travels the route under investigation and the recorder reading can be noted at suitable control points. The distance between control points can be measured by mileometer readings or, in the case where short distances are concerned (less than 500 ft. or so), can be determined by scaling from a plan or by direct measurement on the ground.

Table II gives details of some city centre fuel consumption figures.

TABLE II

Location	*Length ft.*	*Petrol consumed on runs (1 unit = 0.0005 gal.)* 1st run	2nd run	3rd run	average	*Equivalent miles /gal.*
New Street Victoria Sq. to:						
Temple St. to:	740	18	17	7	14	20.0
Corporation St.	320	5	7	6	6	20.1
Corporation St. New St. to:						
Cherry St. to:	510	11	15	25	17	11.4
Bull St.	450	12	10	8	10	17.1
Bull St. Corporation St. to:						
Colmore Row	610	18	19	18	18.3	12.6
Colmore Row Bull St. to:						
Temple Row to:	835	17	15	22	18	18.7
Victoria Sq.	815	9	9	14	10.7	29.0
Totals	4,280	90	92	100	94	17.7

Test Vehicle—1½ litre saloon—average petrol consumption 30 miles per gallon. i.e. 55.2 units of petrol to cover 4,280 ft.

Petrol consumption—Birmingham City Centre

TRAFFIC ENGINEERING IN A COUNTY BOROUGH

by John L. Beckett, M.I.C.E., M.Inst.Mech.E., M.Inst.Mun.E., M.R.S.H., M.T.P.I.

Complimentary to Mr. Ogden's description of 'Traffic Engineering in a County', TRAFFIC ENGINEERING & CONTROL invited the County Surveyor and Town Planning Officer of Leicester to describe the organization of Traffic Engineering in a County Borough.

THE rate of growth of the volume of traffic using our roads steadily increases and the recent report issued by the Road Research Board to the effect that the actual measured increase in volume for the years 1958-59 was 12 per cent, against an anticipated increase of 7 per cent, confirms the size and urgency of the problem of accommodating a large and ever increasing volume of traffic on our urban streets, the layout and width of which, in most of our towns and cities, have remained unchanged for over a quarter of a century. The solution of the problem lies in a coherent traffic plan involving both the construction of new roads and the development of the full inherent traffic-carrying capacity of our existing urban streets by the use of the techniques employed by the traffic engineer.

The pressing nature of the traffic problems in our larger towns and cities is such that the conventional local government structure, whereby executive responsibility for traffic matters lies in the hands of several different committees, should be reviewed and if necessary adapted in the light of changing circumstances.

In Leicester, like most cities, certain of the work, such as mandatory signs and certain traffic control features involving the police, came under the jurisdiction of the Watch Committee, whilst the Town Planning Committee had a considerable part to play in the design of new roads, road junctions and amended layouts, and the Highway Committee had the function of translating those schemes into working practice together with the other functions of maintenance and improvement of highways and other such work normal to a Highways Committee. Whilst the City Surveyor was the official responsible for this work to each of those three committees, the necessity to place matters before different committees, together with possible delays where decisions were not always in line when looked at from the particular committee's point of view, often caused some delay in the implementation of proposals.

In Leicester, after such a review of functions, a special Traffic Committee was set up to deal comprehensively with various aspects of traffic within the City and to co-ordinate all the functions of the local authority in relation to traffic. The new Committee is composed primarily of members, including the Chairman and Vice-Chairman of Committees interested particularly in traffic, namely the Highways, Town Planning, Watch and Transport Committees and, therefore, enables the views of these differing interests to be expressed at one meeting so that decisions arrived at are likely to be acceptable to the parent Committees. The City Surveyor is the chief co-ordinating Technical Officer for this work and the first meeting of the Committee took place in July 1959.

The Committee incorporates all the executive functions, such as traffic regulations, traffic signals control and the establishment of new car parking facilities, surface and multi-storied, which are necessary for a comprehensive development of the full capacity of the existing city streets and, in addition, advises the committees that still hold executive functions in relation to the siting and construction of new roads on the needs for, and the priority of, such siting and construction in the light of reports presented to the new Traffic (Special) Committee on the trends and distribution of traffic. There is no doubt that the establishment of the Committee has simplified and speeded the administrative procedure in traffic matters in Leicester.

In co-ordination with the establishment of the Traffic (Special) Committee on the executive level, a Traffic Engineering Section has been set up in the City Surveyor's Department to deal with the increasing load of work undertaken by it in connection with *traffic* as opposed to the conventional *highway* matters, and the concentration of this work as a result of the establishment of the new Committee. The Traffic Engineering Section is composed of a team of traffic engineers to which the other assistants in the office are seconded as and when the need arises and the section forms an integral part of the department.

The duties of the section on the administrative level follow roughly the responsibilities of the new Traffic (Special) Committee at the executive level and, by the very nature and urgency of the present traffic problems, the major portion of their present work is devoted to the preparation and presentation of schemes for improving the capacity of existing City streets.

As the result of a wide and detailed surveys of parking needs conducted in 1954 and 1958, a complete programme of parking spaces, including nine multi-storied garages, has been approved and rapid progress has been able to be made with the leasing of these sites. About four of these are likely to be in course of construction during 1961.

The responsibilities of the section can be divided under the following headings:

(*a*) The collection, collation and analysis of the basic traffic statistics upon which the design work of the section is based, including studies of traffic growth, distribution and generation, journey time surveys and the location of the causes of traffic delays and congestion, the recording of road accidents and the location of accident black spots.

(*b*) The preparation of schemes for the improvement of the capacity of the existing street network by gyratory and parallel route one-way streets, the regulation of traffic, the marking of carriageway lanes and the provision of additional lanes for peak morning and evening traffic flows, the re-timing, re-phasing and linking of traffic signal installations and the provision of filter lanes, the channelization of road junctions and the removal of local traffic bottlenecks.

(*c*) The preparation of further schemes for the provision of additional car parking facilities in surface and multi-storey car parks and at parking meter sites.

(*d*) Advising upon the design of new roads and road junctions and establishing the scale of priority for new road construction on the basis of benefit/cost studies.

Today's traffic sometimes seems akin to trying to get a quart into the proverbial pint pot. Traffic engineering is no universal panacea for traffic ills but can ensure that we get the pint in full measure.

ROAD SAFETY

Session for school children on the science of roadmanship at RoSPA House.

RESEARCH AND EDUCATION

by ARTHUR J. W. PITT, D.S.O.
Head of Road Safety Division (RoSPA)

RESEARCH is needed in the field of Road Safety, and particularly in the field of Education which is RoSPA's responsibility, first to establish that a specific problem exists and second to chart the way to overcome it. Just as it is vital before undertaking a road building or road improvement programme, so one must carry out research before trying to alter the behaviour of road users.

Thirty years ago statistical research indicated that the very high death rate on our roads included a disproportionate number of child fatalities. The slaughter amongst them was appalling. There was a problem and careful plans were laid to combat it before RoSPA's Child Safety Service for Schools was launched. This Service, which is built round the Kerb Drill, has, in conjunction with a steady general propaganda, achieved remarkable results. In 1930 there were 1,685 child road deaths; by 1959 the figure had been reduced to 680.

Cycle Training

This was not enough, however, because further research indicated that death on the roads amongst older children remained high. The reason for this was that they came to regard the Kerb Drill as kid's stuff and, what is worse, they seldom saw their elders practising it. It meant that some scheme had to be devised by which the training of children could continue in a form that they were willing to accept. As a result just after the war RoSPA started to pioneer cycle training. At the time we had insufficient resources to make this training available universally and further research was undertaken. The Ministry of Transport sponsored a Working Party and from their Report was born the National Cycling Proficiency Scheme administered by RoSPA. In 1959, its first full year of operation, 130,000 children were trained and tested, of whom 100,000 passed the test. It was a fine start towards the target of 310,000 between the ages of 10 and 12 who should be trained annually.

Problem of Motor Cyclists

Today the greatest problem on our roads is probably that of motor cyclists. There is the same situation as before: youngsters wanting to move on to their next stage of development and the need to train them for it. Statistics have revealed the size of the problem. Research is being undertaken by all concerned—the Ministry of Transport, RoSPA, Road Safety Committees, the RAC and the Auto Cycling Union, so that the RAC/ACU Scheme launched by the two latter organizations can be expanded to provide training on a national scale.

It is essential to highlight this steadily developing programme to train a nation of road users. The Child Safety Service for Schools has achieved remarkable results and there is no doubt that in the future the development of its two logical successors will show the same gratifying results. What is more, the thorough, systematic training of youth in roadmanship will mean that the adults of tomorrow will have had that proper grounding necessary to eradicate the faults of today.

It is necessary to emphasize this because so often the headlines feature research into subjects which appear more interesting. Whenever manners or morals can be brought before the eyes of the general public there is an immediate response. This has happened over the problem of road users and drink. Cranks, zealots and interested parties either shout or subtly inject their views. Press, radio and television seize on the subject and committees discuss it. Research by eminent organizations and people has been inaugurated but, as happens only too often when it is a matter of manners and morals, much of it tends to be wasted. Too many people have made up their minds and will not alter them. Further, they spend all their time and ingenuity twisting the results of such research to suit their own established ideas.

Drink Hazards

There has indeed been a great deal of research, and the difficulty is to decide upon the appropriate action. Probably no sweeping reform is necessary, just common-sense action along two lines. Firstly, an educational effort to warn road users—and here I must emphasize road users because so many associate drinking with the driver only—of the dangers of drink when they use the roads: this to be directed towards destroying a few illusions that may linger in the minds of quite honest and sincere people and to making it clear to them that in fact a change does take place in them whenever they have a drink. Secondly, it appears that research is indicating that there should be some strengthening of the law. So far there is no clear evidence from countries where

(*Concluded on page* 613)

METERS v DISCS

J. T. DUFF

AT a meeting of the Institution of Civil Engineers Study Group on December 8, 1960, a discussion on 'Parking Control' was opened by Mr. Duff, Senior Engineer, Traffic Engineering Branch, Ministry of Transport. His prepared paper is given below, together with a report of the discussion that followed its presentation.

The purpose of limited waiting restrictions is to reserve what space is available at the kerb in busy streets, for the vehicles of drivers who wish to do business in these or adjacent streets, by imposing a time limit. The all-day parker must move from these streets to less busy ones or to parking places and garages off the highway. As the demand for parking increases this rationing of kerb space has to be extended to more and more streets. The time limit is, however, very difficult to enforce, particularly if the restrictions are widespread, and hence the need for some mechanical timing device as an aid to enforcement. A further means of discouraging all-day parking is to charge for parking by the hour at a rate which will not be too serious for short stays but which becomes expensive for frequent long stays. A device which achieves these two aims is the parking meter.

Before the Road Traffic Act of 1956 no legal powers were available to make a charge for parking on the highway. The 1956 Act, in addition to legalizing this, laid down the conditions under which parking meters could be used for this purpose. An important provision was that any surplus revenue obtained was to be devoted to the provision of parking facilities off the street.

Parking meter schemes are expected to operate somewhat differently from unilateral restrictions which are applied only to individual streets where the need arises. Parking meters are to form part of a comprehensive traffic and parking plan affecting a complete area of a town. Inside such an area, parking is permitted only at sites where parking meters are installed, and on payment of the appropriate fee. A fairly large area covering some 2,300 metered sites in Westminster and St. Marylebone is already in operation and there are proposals for extending the area both in these two boroughs and in the neighbouring boroughs of St. Pancras, Holborn and Paddington. A number of provincial towns have more recently been given powers to proceed with parking meter schemes.

The parking meter consists basically of a timing mechanism which is started by the insertion of a coin. The period paid for is indicated by a pointer which gradually returns to zero over a graduated scale as the time paid for elapses. A less common arrangement is to have a fixed pointer and a moveable graduated scale. When the time paid for has elapsed a flag, or some other device, appears which can readily be seen by an attendant who patrols the streets at intervals. Two types of parking meter are in common use, the manual meter and the automatic meter. With the former the driver has to turn a handle or operate a lever after inserting each coin. This operation sets the timing mechanism in motion and also winds the mainspring which is therefore kept at nearly constant tension. With the automatic meter the driver has only to insert the coin but the mainspring has to be wound (usually once per week) by an attendant.

The meters can be designed to give a single fixed period of time for the insertion of a single coin or to allow the option of one or more periods according to the number or value of coins inserted. For example, in London the insertion of one sixpence buys one hour and the insertion of two sixpences or one shilling, buys two hours. More elaborate arrangements with up to five coins are operated in other countries. The 1956 Act allows both the period and the amount to be varied but the standard period can only be split into two equal parts and the payment must be proportional. It is not possible for example to charge sixpence for half an hour and one shilling for two hours nor threepence for one hour and one shilling for two hours.

The practice for dealing with drivers who overstay the time paid for varies somewhat in different countries, but a common arrangement is for the attendant, on noticing the expired flag showing, to place a ticket on the windscreen of the vehicle requiring the driver to pay a fixed fine. In this country the procedure is similar, except that there is no fine. At the expiry of the time paid for (either one or two hours), which is indicated in London by the appearance of a yellow flag, the driver becomes liable for an excess charge which must be paid within a certain number of days to the local authority either in person or by post. No offence is committed. The excess charge in London is ten shillings. Only at the end of a further period (known as the excess period and lasting for two hours in London) is an offence committed and the driver becomes liable to prosecution and to have his car towed away. In London, this excess period is timed by the meter and, at the end of this period, a second (red) flag appears to denote that an offence has been committed.

Although in London the driver is given the option of buying one hour or two hours initially, it is an offence to return and insert a further coin in the meter (meter feeding). For example a

driver who buys one hour is not permitted to return at the end of 55 minutes and purchase the second hour. The practice of meter feeding is obviously not easy to detect, but the nuisance and expense of paying for all-day parking in this way limits the amount of abuse. It is also an offence to use the unexpired portion of time left by a previous driver without inserting a coin, though the meters in London are designed to add on this time to the time paid for up to the maximum of two hours. For example, if a driver inserts sixpence in a meter showing 20 minutes from a previous payment he will receive one hour and 20 minutes for his sixpence.

Advantages claimed for the parking meter are:

(i) It increases the turnover of parking places by discouraging long-term parking.
(ii) By increasing the chance of finding a vacant space it reduces the amount of cruising in the area.
(iii) It improves traffic flow by eliminating double banking.
(iv) It aids enforcement by encouraging voluntary observance of the time limits.
(v) It reduces the time and difficulty of parking a vehicle. This results, in fact, from the more orderly spacing achieved by the marking of the bays rather than from the presence of the meter itself. This advantage is also obviously only achieved at the expense of a reduction in the number of vehicles which can be accommodated at any given moment.

A survey of the initial installation of parking meters in Westminster gave the following results:

In the metered area the number of vehicles parked at the peak hour falls from 1,469 to 679 (54 per cent reduction), as a result of the limitation of parking to the metered spaces. The turnover throughout the day, however, dropped by only 24 per cent. Vehicles travelling through the metered area showed a 10 per cent reduction in journey times whilst the time taken to visit various premises in the area was similarly reduced.

One of the two functions of the parking meter, namely the discouragement of long-term parking by the price mechanism, gives rise to frequent objections by motoring organizations and others. An alternative arrangement to avoid this objection was first introduced in Paris and has since been followed in other towns in France, Austria, Italy, Switzerland and Greece. In the most congested part of central Paris an area, known as the 'Blue Zone', has been designated inside which parking is limited to one hour during the hours 9 a.m. to 11.30 a.m. and 2.30 p.m. to 6 p.m. During these hours, every vehicle parked in the area must display a special cardboard disc. This consists of a folded square of cardboard with two small apertures on each side and inside which rotates a disc, with arrival and departure times. On arrival, the driver sets the disc so that the hour of arrival appears in one aperture and the second aperture then automatically displays the time by which the driver is required to leave. For example, if a driver arrives at 10.20 a.m. he sets the disc for 10-10.30 a.m. arrival and the second aperture shows (in larger red figures) the time of departure, that is 11.30 a.m. The time allowed thus varies in practice between one and one and a half hours according to the exact time of arrival.

Overnight parking is allowed for residents without the use of a disc, but the vehicle must be removed by 9 a.m. If a disc is displayed showing arrival 'before 9 a.m.' the vehicle is allowed to stay till 10 a.m. A vehicle arriving after 11.30 a.m. is allowed to stay to 3.30 p.m. (to cover the long lunch period usual in Paris).

The discs are distributed free of charge by various industrial and commercial undertakings who are allowed to have advertising matter on part of the disc, which must otherwise be of the approved pattern. Several million discs have been issued to cover an area containing some 5,200 parking places.

The offences which can be committed under this system are:

(i) Failure to display a disc.
(ii) Not leaving at the end of the time allowed.

Fig. 1. Parking meters in Zurich. *Photo Venner Ltd.*

(iii) Setting the time of arrival incorrectly.

(iv) Returning to alter the setting.

The first two are dealt with by a ticket system which imposes a fixed penalty of about 15 shillings.

Disadvantages of the disc system compared with a parking meter scheme are:

(*a*) Apart from streets where no-waiting regulations are in force, drivers are allowed to park almost anywhere, e.g. close up to intersections. With a parking meter scheme, on the other hand, the bays are precisely defined and limited to places where vehicles can wait without causing obstruction.

(*b*) A greater onus is placed on the driver to display the disc and set it correctly. Opportunities for evasion of the restriction are easier.

(*c*) The small size of the aperture, the absence of a price mechanism to encourage voluntary observance, and the need to check the discs at fixed times of the clock, all require a much larger enforcement staff—at least three times as many.

(*d*) No surplus revenue is available for provision of off-street parking facilities.

(*e*) The cost of operating the scheme, which is at least as great as for a parking meter scheme, has to be borne by the general ratepayer, instead of by the individual motorist who parks in the area.

In September 1958, in one month, nearly 65,000 tickets were issued for infringements in the Blue Zone, of which 29,000 were for absence of a disc and 19,000 for parking beyond the time permitted. Between the start of the scheme, in November 1957, and the end of March 1959, over 1.1 million tickets had been issued, with a peak of 104,000 in the month of December 1958. This represents some 2,500 every week-day, from which it is estimated that about 500,000 per year is being collected in fines from the motorist. These figures suggest that the scheme is very far from being self-enforcing.

Mobile Meters

Mr. Duff also mentioned a scheme which sought to retain most of the features of the disc whilst enabling a charge to be made for parking on the street. It involved the use of a mechanism known as the parking clock. The motorist purchased the clock with a given amount of parking time prewound into it. On arrival at a parking space, he was responsible for selecting the appropriate rate and duration according to the area, and for starting the clock running. A revolving disc indicated to the attendant that the clock had been set and, at the end of the period allowed, a flag covered the disc and denoted that an offence had been committed. If the motorist arrived back before the end of the period allowed, he stopped the clock and so paid only the actual time for which he was parked. When the total time paid for had been used up he had to exchange the clock for another. (Fig. 2.)

Fig. 2. The flexible clock meter to be fitted to windscreens, referred to during the discussion.

Discussion

Much of the discussion, which followed the presentation by Mr. Duff of his paper, revolved around the comparable merits of fixed parking meters, time discs as used in the 'Blue Zone' in Paris and elsewhere, and mobile meters. A contributor with experience of the Westminster City Council Parking Meter Schemes said that with approximately 1,800 meters covering a four square mile area, and 15.8 miles of streets, it should now be possible to compare zones controlled by the disc system and by the parking meter. The effectiveness of the two systems could be judged by the number of tickets issued. According to Mr. Duff, and according to a paper read by Police Captain Ramseyer at Basle in Switzerland, 64,000 tickets and summonses had been issued in the 'Blue Zone' in September 1958, at a time when there had been actually 5,200 parking places in the 'Blue Zone'. In the following month they had increased to 6,000.

Analysing the tickets and summonses, one found that about 52,000 were issued in Paris, and the summonses were answerable in respect of offences which had counterparts dealt with by tickets issued by the Westminster City Council's parking attendants. If expressed in terms of the 1,800 meters in Mayfair, the corresponding number of tickets that would have been issued on the disc system, was the staggering total of 18,000 each month. In actual fact, in Westminster, operating on parking meters, 7,250 tickets a month had been issued, including the yellow tickets for the excess charge, the red tickets issued to people exceeding the two hours of the excess charge, and the blue tickets issued to people who cheated and did not pay the meter at all. The tickets issued in the 'Blue Zone' outnumbered by approximately two and a half times the tickets issued on the meter system. It had also to be borne in mind that in Paris in the 'Blue Zone' the ticket was virtually a fine: it resulted from a definite offence.

The excess charge in Westminster and elsewhere was a right. The motorist was entitled to buy extra time at a slightly higher cost if he so wished. Of the 7,250 tickets issued, about 92 per cent had been simply in respect of motorists who had opted for excess time—two hours for 10 shillings. Thus, only something like 8 per cent of those tickets had been in respect of people who overstayed their two hours or the two hours of the extra charge. Further, over 70 per cent of the very large percentage who received yellow tickets, paid their 10s. cheerfully to the City Council without any further action being necessary. A very small percentage of those receiving tickets had to be taken to court, consequently only a small burden was placed on the courts, compared with the fantastic number of summonses answered in Paris. He believed, further, that at the present moment the courts in Paris had an incredible backlog of summonses, and that it was often many months after receiving a summons that a person might be called upon to answer it. In Paris, the cost to the motorist was about £500,000 in fines, on which the motorist saw nothing in return. In Mayfair, on the other hand, from their 1,800 meters the motorists would benefit to the extent of approximately £50,000 a year: that amount came back to him in the provision of off-street parking to which it had to be devoted. The actual overall cost to the motorist in Mayfair, from start to finish, had been about £134,000 a year paid in excess charges and/or in fines. The comparable figure would have been £400,000 for the same number of meters as there were parking places in the 'Blue Zone'. On these figures it was self-evident that parking meters were an instrument of control with great advantages to offer over the disc system.

Oversized Bays

Another contributor referred to the size of parking bays which were normally 20 feet long, which was advantageous for getting in and out, although one's car might not be as long. However, there was provision for manoeuvre in each bay, but he considered it was possible to economise on space by utilizing manoeuvring space per two bays. That still gave a car about 16 feet with four feet for manoeuvring, and the two bays then equalled 36 feet compared to 40 feet before, so this would provide a 10 per cent reduction in kerb space, giving 10 bays instead of nine. Bays might also be of different sizes.

He drew attention to the 'excellent journal' *Traffic Engineering & Control* for November and an advertisement in it for a parking clock meter, as referred to by Mr. Duff, and he thought it might be very useful for use in ordinary

municipal car parks as well as on the streets. When a driver parked, he put the clock behind the windscreen of his car and his time could be checked off. There had also been an advertisement for a different sort of meter for use in car parks and which issued a ticket. On the money being inserted a ticket was issued, rather like a railway ticket, giving the day and the time at which the period would expire, and with that device only two or three such ticket selling machines were required in the car park rather than a large number of parking attendants.

One speaker suggested that the acid test of any system of parking control was the turnover, or traffic generated, and it was a matter that ought to be thought about carefully. If the whole of Inner London were controlled, the combined turnover produced by the controlled zone and by long-term off-street parking facilities might possibly generate rather more traffic than anticipated and lead to rather premature saturation. It deserved careful thought, and there was also the problem of enforcement, which was a difficult one, and by no means completely cured by meters, as distinct from any other system.

Speaking from the point of view of the Metropolitan Police, another contributor said that parking meters had had a substantial time of real trial in conditions which included continually increasing traffic movement and circulation, and they had proved a most effective remedy. He did not propose to go into comparisons with other arrangements but he did feel that it was only right that the voice of authority which dealt with the enforcement of traffic regulations should be raised to point out the advantages, or to underline them. The aspect which affected the police authority was the frequent, sudden, erratic and quite unexpected nature of calls for the police to go all over the place in order to sort things out. With a hard worked force, whether of police or wardens, one did not want to have trivial calls taking up valuable police time, and there was no doubt that from that point of view alone the meter scheme had been well worth while.

The chief trouble with a lot of Central London streets was their width. There was no doubt that with the meters there had been a great improvement in regard to congestion in Central London and it was quite clear that not only was the general circulation of the whole area cleared up, but also it had been made much more feasible and simple for people to go about their legitimate business.

In police work it was found that crude simplicity was better than enlightened complication. They did not want a man to go to one street and find he could park two hours for a shilling and four for two shillings, and then find that in the next street it was sixpence for one hour and a shilling for two hours. It was necessary to sacrifice something for simplicity, and he felt that in everything they did they should aim at simplicity. Another great benefit resulting from the introduction of meters was the reduction of the great mass of signs; and when he used the word 'mass' they had only to recall the various signs that had been in use in all sorts of streets and in all sorts of conditions, in order to realize that things were terribly complicated for the average man. They had now got down to bare bones, and they did not want to see any further complications unless they were very essential.

A further speaker said that the motoring organizations were not opposed to the discouragement of the long-term parker on the highway, but to the use of a price mechanism for that purpose, because they believed it could be achieved just as effectively by a disc scheme. He criticised Mr. Duff's paper because he felt it had a strong bias, without any real justification, in favour of meters as opposed to discs. It had been alleged that with the disc system drivers were allowed to park almost anywhere, whereas with parking meters the bays were precisely defined. There was no reason why with a disc system they should not mark with kerb signs lengths of road on which parking was allowed or was not allowed, including sections by traffic lights, and in that way the disc parking would be confined to the points where they wanted it. It had been alleged that there was a greater onus placed on drivers to display the disc and to set it correctly, but he did not really see how that point could be sustained, nor could he agree that opportunities for evasion of restrictions were easier with discs. It was well known that much 'meter feeding' took place, and he believed that an office boy, sent out to unlock the door of a car, get in and turn the disc round, would be much more likely to be detected than if he went out to feed the meter.

Fig. 3. Example showing the amount of waste space that must be reserved when parking bays are 20 ft. in length.

The absence of the price mechanism with the disc was not a convincing argument. The inconvenience of having to move a car every two hours was much more likely to deter people than having to pay another shilling, so he did not think it was really the price mechanism that made people move on. With regard to the point that discs could not be checked every two hours, it depended to some extent on the type of disc in use. There were types which did not require regular checking and could be used in something like the manner of a clock face. The lack of any revenue from discs was a more valid objection, but some means ought to be found for providing funds to operate the disc system from the ticket fines for the infringement of the regulations, and in that way the offenders would pay to assist with the orderly parking of those who did abide by the law. There were a great many infringements of the regulations in the Blue Zone of Paris, but not sufficient for the Paris police to regard the scheme as a failure.

He suggested that the alleged disadvantage of parking discs was largely illusory, and certain snags which may have arisen in a largely successful first experiment in Paris were not inherent in disc schemes, and could quite easily be overcome. In fact, he thought the disc system had certain clear advantages. It was simpler to introduce. It was more flexible, and could be varied in the light of experience without difficulty to any desired extent. It was not necessary to pull it up as it was if a meter was in the wrong place. The scheme was also more likely to appeal to the motorist because it provided a system of control without the need to make a charge. It overcame the need to erect unsightly obstructions by the kerbside and made for a big saving in kerbside space for parking.

To sum up, he thought that a disc scheme should be given a trial because it had operated successfully in many towns abroad and did seem to have certain advantages over meters.

Another contributor stated that it had been claimed that an advantage of the meter system was that it resulted in orderly spacing, but he wondered whether that was really an advantage because the whole purpose of parking schemes was to achieve some control of those parts of the carriageways in the central area where it had been decided in advance to permit parking. It had already been decided to do without one or two traffic lanes in that particular street, therefore some form of control had to be introduced. Did it really matter whether the vehicles that were parked in those lanes were parked in 20-ft. bays or parked nose to tail? He would have thought that, since parking schemes were instituted because parking space in the centre was at a premium, their objective should be to accommodate the maximum number of cars and that would not be achieved by the parking meter, but it might be by the disc scheme.

That the parking meter itself did nothing except to make the enforcement officers' job easier was the view of another speaker. It did not make it easier in that it materially reduced his work; the work was the same; they paid for the same whether they had the meter or not; but it did make the general public more susceptible to enforcement, They would stand for enforcement—except for about 15 per cent of the population who would try to get away with it whatever happened.

With regard to improved traffic flow and elimination of double parking, those things only happened where there was adequate enforcement. By good enforcement, and by the introduction of loading bays, double parking could be reduced, but without enforcement it was impossible; the meter itself did not achieve it. Meters aided enforcement by increasing voluntary observance, one study he had recently made showed that nine per cent of the parkers used 20 per cent of the space hours, and that 45 per cent of those people were employed within half a block or 300 or 400 feet of where they parked their cars. Of the over-parkers 11 per cent had been merchants taking the space of their own customers and feeding the meters, and that practice in a small town had amounted to about a 60 car space lot.

Car Parking Survey

The British Road Federation has invited 400 local authorities to participate in a car parking survey. It is hoped that the results will be available by mid-1961. One objective of the survey is to collect information as to the extent to which off-street parking garages are being provided, the problems confronted in connection with land values which handicap their provision and to ascertain whether in such circumstances financial assistance is necessary. It is hoped to publish in the March issue the questionnaires and the forms to be used in this survey.

ROAD SAFETY

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severe laws and strict enforcement are practised that these have reduced the number of accidents caused by drink to a very marked extent although new evidence does now show they have had some effect. If this is true, then all we may need is an alteration of the law to admit scientific evidence as to the amount of alcohol in a defendant's system. This would establish a fact, and would help to prevent the clever lawyer from making a fool of the doctor and policeman when giving their honest opinion.

Physical Disability

As to questions where it is still necessary to establish that they in fact constitute a road safety problem, a whole range of these exist under the heading of physical disability. Many people believe that bad eyesight, heart disease, epilepsy, diabetes, deafness and other physical disabilities are responsible for road accidents. This may be so but here only the first stage of research has been reached and it is not known for certain. Careful research is necessary under these circumstances. An important reason is because it has already been established that a complete and effective medical check upon all road users would be an administrative and financial undertaking of a very high order indeed. It would therefore be foolish to spend much money and effort if the problem did not exist.

The primary reason, however, is that we must always remember that the use of the roads is absolutely vital to every person if he is to live his life to the full. What is more, those who may be physically handicapped need the help of others as much as possible in order to do so. It is essential, therefore, to be quite sure of the facts before any action is taken which might ban large sections of the public from a full use of the roads. Perhaps the most heartwarming result of research and education which has been seen in the road safety movement for some time was a demonstration at the Scottish Accident Prevention Conference at Inverness in March of last year. There two deaf children demonstrated how well they were able to undergo the National Cycling Proficiency Training and Test. Mr. William Johnson of the Aberdeen City Police has devoted a great deal of original research into the problem of training these children and has laid the foundations whereby they and others are able to overcome their handicap and to use our roads as well and as safely as any other person.

Finally, I should like to say a few words on a problem of which the general public is as yet hardly aware. Our training of youth has proved so successful that now statistical research is revealing a very grim gap. I refer to the under fives. These are children who so far we cannot reach effectively because they are not at school. It will appal every right-minded person when they learn that for all children under 16 the ages of two and three were in 1959 very markedly the worst for child road deaths. You might think that eight and nine would be more dangerous ages. Well, in 1959 road deaths for each were respectively 35 and 34. Against this 68 children aged two died on our roads, and 68 aged three.

A great deal of research has already been put into this problem. It has been established that it is of serious proportions and a plan has been devised to reach these children in their homes and, above all, to reach their mothers. It requires only one thing and that is the thing that always comes at the end of research, the money to put it into action. An effective scheme is ready but it will cost £7,500 annually. RoSPA does not have that full amount available from its resources.

PROFILE

Kenneth Summerfield

EXCEPT during the war, Kenneth Summerfield, County Surveyor of Oxfordshire—and incidentally, our Editorial Consultant on Signs and Carriageway Markings—has always worked for local authorities, and if it were not for a straightforward, undramatic manner, it would be seen at once that local government has for him an intense, in fact, a philosophic, importance. Yet, as with many people, the details of his early career were largely accidental.

'Ken' Summerfield, as he is known in the profession, had an ordinary boyhood in Guildford, Surrey, and in Lincoln. He attended Grammar Schools and Birmingham University, where he gained first class honours in Civil Engineering and a research scholarship, not exactly commonplace achievements, but typical of many of the men who have emerged as this country's first traffic engineers. Another thing that was typical for young Ken, however, was less happy. It was the early nineteen-thirties, and along with thousands of others, brilliant or not, he could not get a job. Then the County Surveyor of Nottinghamshire, a friend of his father's, offered him training without pay, and soon he found it surprisingly easy to forget dreams of adventure abroad. It was pleasant, too, to learn he had 'been of some use'. He was offered the next vacancy, and, feeding out drawings to bridge-building contractors, he experienced for the first time the thrill that, he maintains, an engineer never loses, when his paper work—perhaps years of it—begins to take shape on the site. Nor is the thrill less in the throb of today's large machines, symbols of power and structural process.

Even now, the older Ken Summerfield remembers gratefully the appetite for new techniques of the progressive Nottingham Bridge Engineer, the late J. A. Riccomini. When Riccomini moved to Kent County Council, he invited Summerfield to join his bridge team, an invitation not least gratifying for its rise in salary. Summerfield was saving up to marry the girl who, with highly individual determination, he had chosen when he was fourteen and she was eleven years old. Before the wedding, however, he had transferred to Derbyshire County Council, and they moved into their first home on September 2, 1939. He volunteered for the Royal Engineers, receiving a direct commission, and early in 1940 was in France, attached to the R.A.F., learning what he considers the great lesson of war—unpredictability. He maintains this was not bad training for an engineer: to be prepared to cope with anything that turns up. In his quietly, definite manner, sometimes stressing the point with gesture, or sitting for a moment, hands over his face as though checking his evidence, Summerfield insists that difficulties are nearly always of a physical nature—such as unusual conditions on the site—and seldom concerned with personnel. Although engineers would not thank him, he admits, for claiming they have affinity with artists, he believes they know similar satisfaction. The culmination of their work is the interpretation of the ideas they have put on paper, their own ideas. The urge to fulfilment is creative, something of a dedication.

Summerfield learned much in the war that was practical, too, in West Africa, Gibraltar, Scotland. Finally, in Normandy, the construction company he was in made 'roads of wallpaper', flattening the little that was left of what had once been houses.

Since the war, Summerfield has remained on road construction, first back in Derbyshire as Chief Assistant, then delighted at promotion, as Deputy Surveyor of Oxfordshire in 1949, County Surveyor in 1957. Oxfordshire, a typical enough 'corridor' county with its 125 miles of national trunk roads, as well as its one thousand and more local roads of every category, has long had the reputation of being forward-looking, with a high level of road achievement. Its Council has a history of enterprise, and a former County Surveyor, the late Col. G. T. Bennett, is still revered as one of the first men in this country to apply traffic engineering principles, as long ago as 1935 introducing the staggered road junction and saving an immense number of lives.

Soon the move to Oxfordshire was revealing an interest that must have been latent for some time. Summerfield was finding that the successful completion of roadwork was not the whole creative satisfaction. It was the means, not the end, the instrument for the carrying out of the real objective, the provision of conditions in which traffic could flow smoothly and safely, in which, in fact, people and the goods they need, could be moved smoothly and safely, With this new, humanistic realization, it was stimulating to be in an environment sympathetic to the idea that traffic solutions cannot be 'unilateral', but must be the combined effort of technicians, architects, planners, psychologists; an environment, too, in which he could try out new ideas, even daring ministerial disapproval by experiments in his special field of road signs.

Summerfield holds, in any case, that local councils are not the remote, impersonal employers people think. On the contrary, the members, working in committees, are easily accessible, committee chairmen expecially, so that quick decision can be reached and there is a sense of continuity and partnership. Above all, the council is directly responsible to the community, and Summerfield, though no more content than anyone concerned with traffic with the inadequate scale of national expenditure, sees as equally vital the political and psychological questions of how much interference there can be with people's liberties, how far people can be

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LIGHTING PHILADELPHIA'S EXPRESSWAYS

by Harold E. Mason

Street Lighting Engineer, City of Philadelphia

WHEN America's first expressway, the Pennsylvania Turnpike, was built, it utilized some abandoned railway tunnels to cut the mountain chains of western Pennsylvania, and its eastern terminus was near Carlisle, Pa. Later, the Turnpike was extended to the New Jersey border and routed around the northern limits of suburban Philadelphia towards metropolitan New York.

From the first, however, it was recognized that a Turnpike connection from Valley Forge into the heart of Philadelphia was a necessity. This highway, known as the Schuylkill Expressway because much of it follows the west bank of the Schuylkill River, was designed some ten years ago, but because of complexities of construction and availability of funds, has only been opened up in sections over the last two years.

In Philadelphia, there are three major connections to the Schuylkill Expressway. The first is to Vine Street, downtown Philadelphia and the Philadelphia-Camden bridge now known as the Benjamin Franklin Bridge, and was completed in 1959. The second major connection is through South Philadelphia to the new Walt Whitman bridge and to southern New Jersey, and was opened to traffic in mid-1960. The third major connection is through northern Philadelphia to Roosevelt Boulevard and the old US Route No. 1, to New York.

The Schuylkill Expressway is a $100,000,000 highway, financed through federal, state and city funds, and by an agreement between state and city which preceded the enlarged federal programme.

In August, 1960, the Commonwealth of Pennsylvania awarded six contracts for the lighting of the Schuylkill Expressway within the city limits of Philadelphia. This lighting within the city limits is required by the Philadelphia Charter. Although the original designs for these lighting installations were formulated at a conference in the offices of Philadelphia's Street Lighting Engineer in 1952, many modifications were made as improved equipment became available, and the installations represent good modern practice.

The main feature of these lighting installations is Vine Street Underpass: As shown in the plan sketch (Fig. 1) this installation involved a 452 ft. main underpass under the Benjamin Franklin Parkway, and a 822 ft. section of alternate open and short underpasses under intersecting streets. Although mercury lighting, such as is used throughout Philadelphia, was considered, the original design called for a continuous row of single lamp fluorescent fixtures in the upper corner on each side of the two 40 ft. wide underpasses for daytime lighting. However, before the specifications were let out for contract, recognition was given to the increasing difficulty which the nation's motorists were having with blind spots when entering underpasses from daylight. The equipment specified was changed first to a two-light fixture, and then to two very high output fluorescent lights. Fixtures were necessary as the walls and ceiling were of painted concrete and no tile was used.

The underpass with its 36 ft. horizontal candles of maintained lighting, presents practically no blind spots at speeds up to 60 m.p.h. With no complaints received, it can only be assumed to be entirely satisfactory to all users. However, 36 ft. candles in the underpass are too much for night use, particularly when the connecting highways are lighted to about 1 ft. candle. On the other hand, the 1 ft. candle needs to be increased greatly because the motorist on entering the underpass at 60 m.p.h. is confronted with sudden physical, light and sound changes. Accordingly a decision was made to leave only every sixth fixture lighted at

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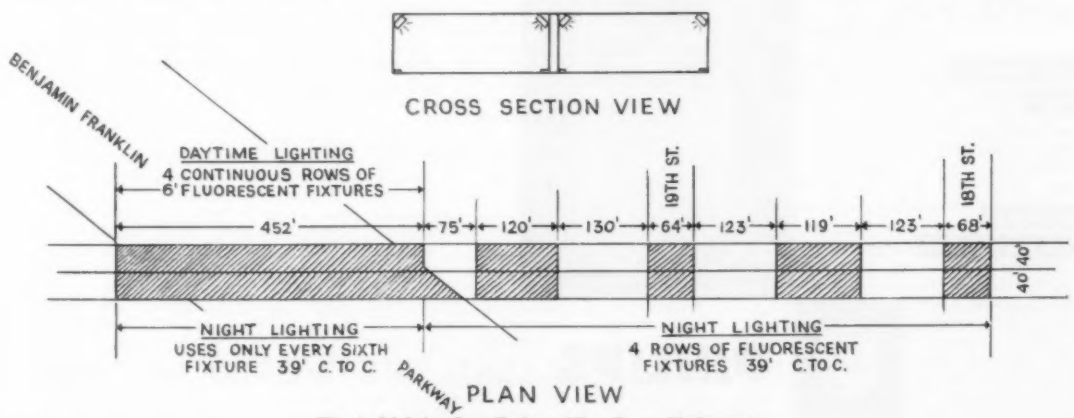

Fig. 1. Lighting Installations, Vine Street Underpass.

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VISUAL PROBLEMS OF MOTORWAYS

In the January issue we published the paper on 'Visual Problems of Motoring' given by Mr. J. M. Waldram to the Illuminating Engineering Society. The following is a summary of part of the discussion that followed.

Opening the discussion which followed Mr. Waldram's paper, Mr. Granville Berry said that the question of visual aids to driving was one of the main subjects discussed at the recent Traffic Engineering Study Week in Nice, and it was generally claimed that from the standpoint of visibility and reduction of nervous tension, fixed lighting was better than vehicle lighting, and that only with fixed lighting could drivers have a clear view of vehicles ahead and of the limits and deviations of the road itself.

Perhaps the most important contribution made by Mr. Waldram in this paper was to kill the popular idea that vehicle lighting was, or could be made, adequate for safe driving at night on fast motorways. With present average speeds on the M1 for cars of about 59 m.p.h., and for vans of 42 m.p.h., it was essential that the driver should clearly see the run of the road ahead, and fixed lighting was in itself a means of such guidance, even under conditions of fog.

'There is no longer any doubt as to the overall advantage of lighting motorways from the standpoint of visibility, driver comfort or safety,' Mr. Berry said. 'Even though night traffic on the M1 is only just beginning to build up, there is evidence that on economic grounds also we are more than half way there. In the case of all-purpose roads, however, we have the advantage of before and after figures for road accidents and it is now urgently necessary that a length of the M1, e.g. Watford By-pass—12 to 15 miles, should be lighted so that before and after studies can be made from both the accident and visibility standpoint.

Fig. 1. *Lighting of Autoroute du Sud, Paris.*

'Without such information we cannot give the final answer—and the £50,000 or £60,000 involved in lighting such a length is small in relation to the cost of the M1—and very much less than the Government will be involved in if electricity supplies have later to be provided on the motorways now being built.

'In France, which has now adopted lighting for motorways, the first such road built was unlighted. In order to

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night. With 6 ft. fixtures this means a lighted fixture every 39 ft. centre to centre, and gives an average of 6 ft. candles, horizontal, maintained for night-time lighting. This has proved to be excellent in practice, and was original in this Philadelphia installation. The same ratio for day to night lighting is followed now in two other Philadelphia underpass installations.

Vine Street also includes 822 ft. of alternate short open sections and short underpasses for intersecting streets. It was important that the motorists would not be confused by changing patterns of light in this area, such as alternating mercury and fluorescent, changing heights, and types of fixtures. Daylight lighting was not necessary in this area, so for night-time the type of fluorescent fixtures with two very high output lamps were mounted at the same height as in the main underpass and at the same spacing of 39 ft., centre to centre. In the short open sections on the crash walls, standard street type very high output fluorescent lamp fixtures are mounted on short twin poles. The City Art Commission specified that no fixtures, and a minimum of light, should project above the open areas of these underpass sections.

For the 30th Street Underpass, like the Vine Street Underpass, the enclosed fixtures with two very high output fluorescent lamps are used in the lighting installation. As the two 26 ft. roadways have only a small divisor strip between, and there are no suitable side walls, a continuous row of fixtures is mounted lengthwise over the centre of each roadway. The fixtures are mounted just above the bottom flanges of the steel beams. Mostly 6 ft. fixtures are used, but where the beams are too close, 4 ft. units have been installed.

As at Vine Street, all fixtures are lighted in the daytime and only every sixth unit is on after dark. The horizontal illumination produced on the roadway by this installation is 18 ft. candles for daytime and 3 ft. candles for night-time.

It is noted that in some similar underpasses in other cities the fluorescent lamp units over the centre of each roadway have been placed cross ways to the roadway rather than in line as in this installation. There is probably not any great advantage for either arrangement but in the case of the 30th Street Underpass the physical arrangement for installing steel beams for the fixture mountings, and the connections between fixtures, plus less glare for the motorist, decided in favour of the lengthwise arrangement.

On the main roads and ramps of the Schuylkill Expressway, 1,242 mercury street lighting units have been or will be installed to produce an average maintained level of 0.8 ft. candle. Mercury luminaries with built-in reactor type ballasts for 400 watt mercury lamps are mounted on aluminium poles with davit type arms. Where the poles are mounted behind a 10 ft. shoulder at the side of the pavement, a 12 ft. davit arm is used. The design for this arm is derived from the 6 ft. davit arm which is so common around Philadelphia.

Originally, it was thought that less light was needed on ramps than on the main roadway, and the ramp designs called for 250 watt mercury. However, because of the small cost difference for installation and maintenance between 400 and 250 watt lamps, and because of the curves, grades, and merging traffic at ramps, the 250 watt specification was changed to 400 watt. Thus, only one size of mercury lamp is used on the Schuylkill Expressway.

The clear mercury lamps installed under the State contract will eventually be replaced with white, bonus type mercury lamps and come under the three-year group replacement plan for mercury lamps. After installation these lighting systems on the Schuylkill Expressway will be operated and maintained by the City of Philadelphia.

The regular maintenance of the Philadelphia street lighting equipment is performed by maintenance contractors under annual contracts awarded by the City. This maintenance also includes the cleaning in the field of all street lighting glassware by ultrasonic equipment mounted on trucks. As far as is known no other city in the world uses this modern cleaning method in the field to produce the perfect cleaning of all glassware.

LIGHTING

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reduce the rising accident rate and improve night visibility a sub-standard lighting installation was provided later and, as Mr. Waldram points out, this reduced accidents at night by 26 per cent. As accidents on the unlighted section rose by 20 per cent, the apparent saving was, however, more like 40 per cent. The latest motorway lighting on the Autoroute du Sud near Paris is of a much higher standard, and is making the road as safe by night as by day and the results should be still better.' (Fig. 1.)

An interesting and significant fact that also emerged was that the accident reduction on the Autoroute de l'Ouest was within 10 per cent of that found in most continental countries on all-purpose traffic roads.

Mr. Waldram had done well to point out that it was necessary to be concerned not just with today's vehicles, but with tomorrow's traffic as well, and if there was to be round-the-clock use of the motorway system, fixed lighting was essential; without it the visual information was not going to be sufficient either for comfort or safety, and as traffic built up accidents would continue to increase.

During the discussion Mr. G. Grime of the Road Research Laboratory said that Mr. Waldram had made use of new techniques for analysing the visual requirements of drivers on motorways, and the conclusions to which he has been led seemed, in the main, to be ones with which it was difficult to quarrel. Referring in particular to Mr. Waldram's remarks on 'Requirements for Motorway Lighting' he said there were two points which he would like to mention and said:

> 'First, I am not sure that it is unnecessary to provide for good visibility beyond the running carriageway, since it is probably very useful to see clearly any vehicles on the shoulder. An efficient edge marking is certainly a necessity and it must be remembered that the marking must show up not only in good weather but in conditions of bad visibility, i.e. in rain and fog. Almost any marking is adequate when the road is dry and the weather clear.
>
> 'Second, we do not know what kind of lighting is sufficient to improve both the comfort and safety of night driving under the special conditions of the motorway. It may be that something less than the best and most expensive would be adequate.'

Mr. Grime added that the motorway is a very convenient unit to study. It brought into prominence problems which were always with us on ordinary roads; it emphasized some and reduced the importance of others, but in many respects the problems were not new ones. Besides the visual problems with which Mr. Waldram's paper dealt, the motorway showed up the importance of vehicle maintenance, and of factors affecting stability in emergencies, such as braking characteristics, road slipperiness and form of shoulder and central reservation; there was also the question of driving techniques to which Mr. Waldram rightly paid much attention.

'I feel sure that this subject of the driver will amply repay study,' Mr Grime said. 'To take one obvious example: driving on the motorway is normally so easy that if a driver travels at a reasonable speed, he may become bored and perhaps inefficient as a driver. It is frequently suggested that to prevent this state of mind, motorways should be made in a series of curves rather than as long straight roads, and motorways have been built in accordance with this theory. But, to my knowledge, there is no experimental basis in studies of driver behaviour for the belief that the gentle curves incorporated in motorway design have any beneficial effect. Indeed, there may well be a net loss in safety. Careful investigations might reveal methods of improving the alertness of drivers in these circumstances.

WORLD TRAFFIC ENGINEERING CONFERENCE

Washington, August 1961

THE list of themes and timetable for the World Traffic Engineering Conference to be held at Washington, August 24-26, 1961, has now been arranged as follows:

Thursday August 24	a.m.	Opening Session.
		Theme I:
		The Need for Scientific Research and the Desirability of International Co-operation in Promoting It.
	p.m.	Theme II:
		Urban Transportation and its Future.
Friday August 25	a.m.	Theme III:
		Designs of Interchanges on Rural Freeways (Motorways).
	p.m.	Theme IV:
		Research into Highway Traffic Accidents.
Saturday August 26	a.m.	Theme V:
		Use of Electronics in Traffic Control.
	p.m.	Theme VI:
		Freeway (Motorway) Operation.

Participants who enrol for the World Traffic Engineering Conference will be also invited to attend the 31st Annual Meeting of the Institute of Traffic Engineers, as well as the International Sessions in Traffic Engineering. Participants will also have the opportunity to take part in a six-day Study Tour by coach and, at the end of the tour, will have four free days in which to arrange private visits.

The timetable for those participating in the whole programme will be as follows:

Thursday, August 17	Depart Paris by air.
Friday, August 18	Arrive Washington.
Saturday, August 19 to Sunday, August 20	At leisure in Washington.
Monday, August 21 to Wednesday, August 23	31st Annual Meeting of the Institute of Traffic Engineers.

To enable participants from Europe who wish to attend the Conference to benefit from the most advantageous terms, an aircraft is being chartered for the journey Paris—Washington—Paris. Accommodation is being reserved in the Sheraton Park Hotel in Washington.

The Conference is being organized jointly by the Institute of Traffic Engineers (United States), World Touring and Automobile Organization (OTA), Permanent International Association of Road Congresses (PIARC) and International Road Federation (IRF). Full details can be obtained from the World Touring and Automobile Organization, 32 Chesham Place, London, S.W.1. Details of the enrolment procedure will then be sent.

PROFILE

Continued from page 614

persuaded or coerced in their own interests—to walk here, park their cars there, submit to this or that restriction. In local communities people more easily appreciate that everything stops, if the town centre stops and, with this closer interest between council and community, he thinks the government will have to take local authorities into closer partnership.

Summerfield is naturally a strong supporter of the County Surveyors' Society, which was formed as long ago as 1885, and of which he is Honorary Secretary. If, however, he looks to the past with pride and at the present with mixed confidence and apprehension, he has great hopes of the future. Nearly a hundred years of county surveying experience is operating in the nation's service. Engineering and technological advances are momentous. Above all, a generation is growing up to whom an immense flow of traffic is natural, not something that has come upon them too quickly to be properly grasped, as with their parents. Not only his own thirteen-year-old son, but children in general impress him with their understanding of fundamentals, with a traffic sense that seems instinctive.

Even a devotee like Summerfield must have relaxation. His wife patiently suffers his 'terrible' piano playing, and will undoubtedly as patiently suffer his struggles to learn the flute, his father's flute which has come to him as an heirloom. At least, she has the compensation of sharing with him the pleasures of real music that Oxford provides. On their holidays, they get even further away, preferably walking on the fells of the Lake District, out of sight and sound of cars. What bliss to be switched back to the life of 200 years ago. But what bliss not to have to wait 200 years for some worthwhile engineering to do. **R.L.**

Memorandum submitted by the O.T.A to Economic Commission for Africa

THE development possibilities of a given region from an economic, social and cultural point of view, depend, *inter alia*, on the facilities within that region for the easy and economic movement of persons and goods. Among these facilities, the road has a particularly important role to play.

The O.T.A. is of the opinion that one of the major tasks to be undertaken as part of the basic equipment of the regions under consideration and eventually of the entire continent, is the construction at the regional level of road networks designed with a view to the rational use of the economic potential of the regions concerned and bearing in mind the ultimate aim of creating a road network for the continent as a whole. However, if the construction of an adequate road track is a necessary condition of the rational development of the movement of persons and goods, it is not in itself sufficient for the full development of this traffic at the international level.

If this international exchange is to develop to the full, it is essential that the many barriers resulting from the various domestic rules and regulations should be removed. The conclusion of a series of international agreements is therefore necessary, with the aim in view either of standardizing certain of these rules and regulations, or of introducing special concessions, by common accord and on the basis of reciprocity.

Some of the problems arising in connection with international road transport have already been settled in world conventions, notably: the Convention on Road Traffic of September 19, 1949, the Protocol on Road Signs and Signals of the same date, and the Customs Convention on the Temporary Importation of Private Road Vehicles of June 4, 1954. These international agreements are in force in several African countries but it is very important that they should be applied throughout the continent, at least in so far as the two conventions are concerned. The attention of the governments concerned should be drawn to this matter and a recommendation could be addressed to them to accede to these agreements without delay, if they have not already done so.

Apart from this, examination of the following matters should be put in hand without delay:

Drivers of International Traffic
Recognition of the validity of foreign domestic driving permits, the holders of which are not domiciled in the country. These permits should authorize the holder to drive abroad any motor vehicle of the appropriate category, regardless of its country of registration, except in the case of professional drivers (carriage for hire or reward) whose domestic permits should be recognized for driving vehicles registered in their home country. This objective can be achieved either by a series of unilateral decisions made as a result of an E.C.A. recommendation, or by means of a formal international agreement providing for reciprocity.

Vehicles in International Traffic
(*a*) *Weights and dimensions.* Agreement on maximum weight and dimensions of vehicles. As stated by the IRF, an agreement of this nature establishing agreed vehicle dimensions for traffic on international routes is needed; such agreement is indeed essential in order to prevent a vehicle being refused entry into a foreign country.

(*b*) *Registration certificates.* Recognition of foreign registration certificates. The 1949 Convention on Road Traffic provides for the reciprocal recognition of domestic registration certificates issued in the Contracting States. Until such day as the provisions of the Convention are applied in all African countries, it is highly desirable that the matter should be settled by a similar procedure to that indicated in the case of driving permits.

International Commercial Traffic
The conclusion of an agreement similar to the General Agreement on Economic Regulations for International Road Transport should be examined. The question of the granting of the necessary licences should also be settled.

(a) *Vehicles in private use in international traffic.* Pending the entry into force of the Customs Convention on the Temporary Importation of Private Road Vehicles (1954) in all countries of Africa, the full application of the provisions of this convention should be encouraged in those countries which are not yet party to it. The possibility of granting greater facilities should be examined, and in particular the waiving of the customs guarantee and the customs document, as is the case in most European countries.

(b) *Vehicles in international commercial traffic.* The above-mentioned customs convention should be completed, as is the case in Europe, by a Customs Convention on the Temporary Importation of Commercial Road Vehicles, similar to the convention signed in Geneva on May 18, 1956.

(c) *Goods.* The possibility of applying to the carriage of goods a customs system similar to that applied to vehicles should be studied, with a view to the conclusion of a convention similar to the Customs Convention on the International Transport of Goods under Cover of TIR Carnets signed in Geneva on January 15, 1959, or accession to this convention.

After dealing with insurance and taxation and making the case for adherence to the conventions relating thereto, the paper dealt with some miscellaneous matters as follows:

There are many other questions relating to road traffic which should be made the subject of complementary agreements to the 1949 Convention and the Protocol on Road Signs and Signals of the same year, with a view notably to creating improved conditions for the smooth flow and safety of international traffic. It is, in particular, important to standardize as far as possible the systems of road signs and signals in use, as well as certain traffic rules such as priority at intersections.

The work involved is very extensive and often complex. Although international road traffic is still little developed in Africa, it is already not without importance in certain regions and will most certainly develop considerably in the future. In view of the importance already mentioned of the development of international traffic, the best possible conditions for future expansion should be created without delay. It is indeed important to act quickly before the position crystallizes in its many aspects in the different countries, as this would make future standardization much more difficult to achieve.

In view of the complex nature of the task and the time probably needed to bring it to a satisfactory conclusion, it would seem appropriate for the Economic Commission to create a subsidiary body for the purpose of studying and solving all the problems posed by the essential development of the international movement of persons and goods, confining itself perhaps for the moment to the regional level.

Traffic Engineering Course
The Lancaster College of Technology, Coventry, has arranged a short course on traffic engineering, to be held on eight Thursday evenings beginning on March 16, 1961. The course will be preceded by an inaugural lecture on Wednesday, March 8. Further particulars can be obtained from the Head of the Department of Civil Engineering and Building, Mr. H. E. Walker, Lancaster College of Technology, Priory Street, Coventry.

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TRAFFIC AND ROAD CLEANSING

by J. C. Riddell, *Director,*
The Yorkshire Patent Steam Wagon Company

Fig. 1. Karrier Yorkshire Sweeper has been adapted to sweep the offside curb on dual carriageway.

THE widespread use of the M1 and M6 Motorways have posed new problems in road cleansing. The principle concern is to remove the surface detritus, and this has led to development in types of road cleansing equipment.

The carriageway is required to be swept to maintain surface drainage, to preserve the properties of the road surfaces, and for reasons of appearance.

The modern sweeper-collector vehicle is able to carry a load of three or four tons. The sweeping speeds vary depending on the quantity on the road surface, but it is usual to find the current vehicles sweeping from two and a half to six miles an hour.

Road Detritus

The quantity of detritus on the road is never constant and the season of the year is the most important single influence, with the heaviest deposits of material occurring at the end of the winter. This is due to the extensive gritting operations, the very wet nature of fields and side roads, and the quantities of soil and sand carried off the land by trucks and tractors. In urban districts, the quantity of sand falling from vehicles is not so great, but

(*Concluded on page* 623)

Fig. 2. Yorkshire Litterlifter Road Sweeper designed to overcome the difficulty of sweeping City centres, and confined spaces.

TEC377 *for further information*

Harry Dimmock buys a Queen

(Dimmock & Seal, Hauliers)

Cheviot Queen is climbing Shap on the A6 to Carlisle: *Lakeland Queen* is pounding up the motorway with a load of machine tools: and now *Border Queen*—youngest of them all—is off to Warrington with 183 miles to do and a shocking wet night to do them in. Like her sisters (fifty-four of them now) *Border Queen* was bought with UDT's help. Perhaps that surprises you? HP's fine for penniless newly-weds, you might think, but surely a prosperous firm like D & S could afford to pay cash? Of course they could—but they prefer not to. *Border Queen*, thundering up the Great North to Gateshead, down A30 to Exeter, along M1 to Coventry, earns her keep and more. So her purchase becomes a simple entry in the company accounts, with payments, plus road tax, insurance, major overhauls and even a set of new tyres (all financed by UDT), set against the extra profits she brings in. All tidily arranged with no messing about with capital.

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(*Continued from page* 621)

coal dust and household ashes, as well as oil and rubber, are present in the road sweepings.

It is clearly useless to attempt to keep the carriageway always free from detritus. The writer remembers well sweeping a street only to find that within thirty seconds the wind had blown pollen into the gutter so that appearance was lost, although the quantity of dirt was negligible. The important function is to keep the amount to a minimum. The quantity of solid matter to be cleared from the road varies for the above reasons and if it is in excess of three tons per mile it is more than most vehicles can accommodate in one pass. If a greater quantity is found, then several passes have to be made which is wasteful in time. The limiting factors are the capacity of the vehicle and disposal of the sweepings.

Road Sweepings and Traffic

The road-sweeper is in constant difficulty with the traffic, one-way streets and traffic congestion, while on the fast roads in the country high speed traffic can cause difficulty. The urban problem has been solved by sweeping at night or in the early morning. Here design is most important because the vehicle is required to sweep quickly and silently and to be ambidextrous. Such machines are now becoming available. Under night or restricted light conditions visibility is important and the striped tailboard is becoming popular with both urban and highway authorities. In future, the flashing beacon may well come into widespread use as an anti-collision device when sweeping.

On the high speed motorways, the problem of sweeping is one of regular attention. When daily passes are made, the load lifted should not exceed on the average five to ten cwt. per mile. The conventional machine should be capable of dealing with sections of dual carriageways some 10 miles long, if the sweeping speed of five miles per hour is achieved. The disposal of the sweeping is simple if the material is used as a filling.

The kerb of the central reservation on the dual carriageway is difficult to sweep and, at the suggestion of the Lancashire County Council, an offside scarifying brush was devised to sweep this central kerb. As the vehicle is travelling in the fast lane, it is clearly desirable to have conspicuous colouring and a flashing beacon would be desirable. Fig. 1 shows the equipment in position. For another authority a right-hand drive vehicle has been supplied.

City Centre Work

The smaller road-sweeper has been introduced to overcome the difficulties of the larger vehicle. Fig. 2 shows such a vehicle—the Litterlifter. These vehicles are designed to carry up to one cubic yard of detritus and paper. By their small size they do not take up so much room on the road and are able to sweep around smaller radii than the larger vehicles. They are designed to travel at a lower speed than the full sized vehicle, but their sweeping speed is approximately the same. As the quantity of road detritus per mile is less in city centres, the smaller capacity of the vehicle is not felt to be a disadvantage.

The increase in the ashphalt areas around blocks of flats and wider sidewalks has produced a demand for vehicles of this nature to go on sidewalks and ashphalt areas. As the loaded bearing pressure per wheel is about ten cwt., it is desirable to design to this figure. Smaller and lighter machines are often found to have insufficient capacity for economic use and their construction is not always robust enough for municipal operation.

Conclusion

The suction sweeper is now on the market and in present forms is slow. It is felt that the suction assistance to road brushes is more economic and it seems unlikely that brushes will be superceded. Brushes are the most effective means of cleaning the surface of greasy material. Wire fillings are now coming into use and the wire brush should enable sweeping speeds to be increased. For urban use, the smaller sweepers similar to that shown in Fig. 2, are likely to become more popular as they are more manoeuvrable and more economical than larger machines. The Dutch are now using such vehicles widely. Certainly the trend is towards specialization in sweeper design.

PACIFIC REGIONAL CONFERENCE

THE International Road Federation, in association with the Australian Road Federation, is holding a Pacific Regional Conference in Sydney, Australia, from February 27 to March 3, 1961, which will be attended by representatives from some 16 countries in the Pacific area.

The theme of the conference, which will be officially opened by the Rt. Hon. Lord Casey, P.C., will be roads as an essential economic and social investment in the modern age of motorized transport. Subjects for discussion will include traffic engineering; the role of international financing and technical assistance in the road and road transport fields; road financing; support for expanded highway programmes; new developments in road research; the future of highways and highway transport; the maximum utilization of road facilities; and highway construction and maintenance. Reports of some of the papers will be published in future issues of *Traffic Engineering & Control*.

The U.K. and U.S.A. delegations will be led by Sir Reginald Biddle, C.B.E., and J. R. Steelman, Chairman of the I.R.F. London and I.R.F. Washington offices respectively. Among the principal speakers will be Christopher T. Brunner, Director, Shell-Mex and B.P. Ltd., and Vice-Chairman, British Road Federation; The Hon. John A. Blatnik, United States Congress, Member of Committee of Public Works of the House of Representatives; D. C. Greer, State Highway Engineer, Texas; the Hon. W. S. Goosman, Minister of Works, New Zealand; J. Burke Knapp, Executive Vice-President, International Bank for Reconstruction and Development; and Dr. R. S. Millard, Head of the Tropical Section, Road Research Laboratory.

Traffic Control Manual

The Bureau of Public Roads, U.S. Department of Commerce, has given official concurrence to the newly approved national standards for traffic signs, signals and markings.

The new standards are contained in a Manual drafted by the National Joint Committee on Uniform Traffic Control Devices, and recently approved by the Committee's member organization, the American Association of State Highway Officials, the Institute of Traffic Engineers, the National Committee on Uniform Traffic Laws and Ordinances, the American Municipal Association, and the National Association of County Officials. The latter two organizations joined the National Joint Committee during the past year and are expected to lend added impetus to the modernization of traffic control devices throughout the United States.

The Manual reflects widely accepted and time-tested traffic control practices as well as the information provided by numerous studies dedicated to searching out the principles for safe and orderly movement of vehicles and pedestrians. The Manual is now being prepared for publication.

Traffic Engineering Course

The Institution of Municipal Engineers, South Wales District, is organizing a Course of Traffic Engineering to be held at the South Wales Institute of Engineers, Cardiff on March 17. Application for attendance should be made to the Hon. District Secretary, Mr. H. Donovan Gauntlett, City Surveyor's Department, City Hall, Cardiff.

Welsh Road Survey

Progress is being made with the Road Survey in South Wales and Monmouthshire sponsored by the Industrial Association of Wales and Monmouthshire in association with the British Road Federation. The field work has now been completed and the analysis is being made and a report on the first stages of the investigation is to be submitted shortly. It is hoped to publish an article on the results of the report in *Traffic Engineering & Control* in due course.

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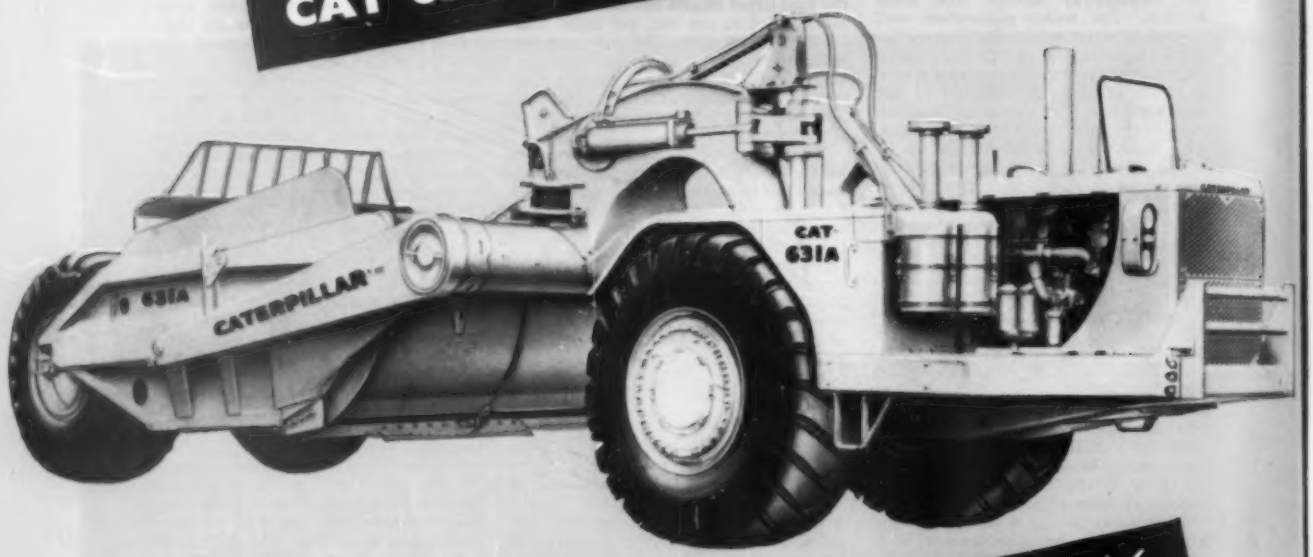

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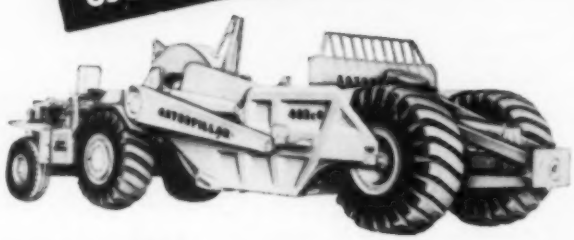

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INDUSTRIAL NEWS AND INFORMATION . . .

THE new Western Avenue underpass taking the A40 beneath the North Circular Road at Hanger Lane, Ealing, employs a special system of graduated daylight, evolved by the Lighting Division of The General Electric Company Ltd. This minimizes the contrast between artificial and natural light on tunnel approaches, and is the first underpass lighting scheme to be sponsored by the Ministry of Transport. Canopies 200 ft. long cover the cuttings leading into the tunnels, to reduce the amount of daylight reaching the road surface. Once underground, motorists drive by the light of fluorescent lanterns. After dark, when far less light is required, reduction in intensity is achieved by switching off alternate lanterns. Cut-off lanterns housing 400 W. MBF/U mercury lamps light the cuttings; approach roads are lit by medium-angle beam lanterns housing 400 W. MBF/U mercury lamps mounted at 25 ft. on tubular steel columns. Pedestrian subways are also lit by fluorescent lanterns.

T.E.C. 158 for further details

Verynyl Road Markings
The photograph below shows a road marking, which was laid in 1958 outside Buckingham Palace and is still in perfect condition. It is made of Verynyl PVC attached to the road by means of a special adhesive. Verynyl strips may be attached to mastic asphalt, hot rolled or cold asphalt and for the best adhesion a smooth surface is required. Chippings and loose aggregate should not be laid over the area where the sign is to be fixed. Pedestrian crossings and almost any lettered sign can be supplied by the manufacturers. With its ease and cheapness of fitting, virtually no maintenance cost and with a very long life, this form of roadway markings is an economical proposition. It is supplied by J. A. Hewetson & Co. Ltd.

T.E.C. 159 for further details

Please use the prepaid cards for the Reader Information Service. For further details of items mentioned in this journal, complete and return the card to us.

An Unobstructive Gully Emptier
The programme of motorways projected for the next decade has created a demand for gully emptying without obstructing the high speed carriageways; the emptying unit must travel on the soft verges. To meet this demand a tractor operated unit has been developed by The Yorkshire Patent Steam Wagon Co.. with the advantage of a dry load discharge. Details of this unit are:—Dimensions: length 12 ft. 9 in. (including towing bar) width 6 ft. 0 in. height 6 ft. 6 in., tank capacities: sludge 310 gallons; water 140 gallons. It is fitted with 'Yorkshire' patented hydraulic sludge compression and discharge resulting in the discharge of dry loads without tipping. The tank is supplied on a steel bolster, carrying tool trays. The suction equipment consists of a balanced crane, 4 in. suction pipe, suction valve—operating both sides and to the rear. Resealing: with clean and/or surplus water at nearside. Hydraulics: the tractor's hydraulic pump operates the hydraulic ram. Vacuum pump: driven from the tractor p.t.o. by an agricultural type propeller shaft. The pump is of the water seal type, preventing overheating and dispensing with internal lubrication. A changeover valve gives vacuum and pressure in the tank at operator's choice.

T.E.C. 160 for further details

A Verynyl road sign.

Three of the new range of plastic warning signs.

Plastic Warning Signs
A new type of warning sign has been recently introduced by Messrs. J. S. Webber. A series of different legends are already available for marking dangerous or unusual loads on vehicles, while other wordings can be ordered. Any type, colour or legend can be supplied to meet special requirements.

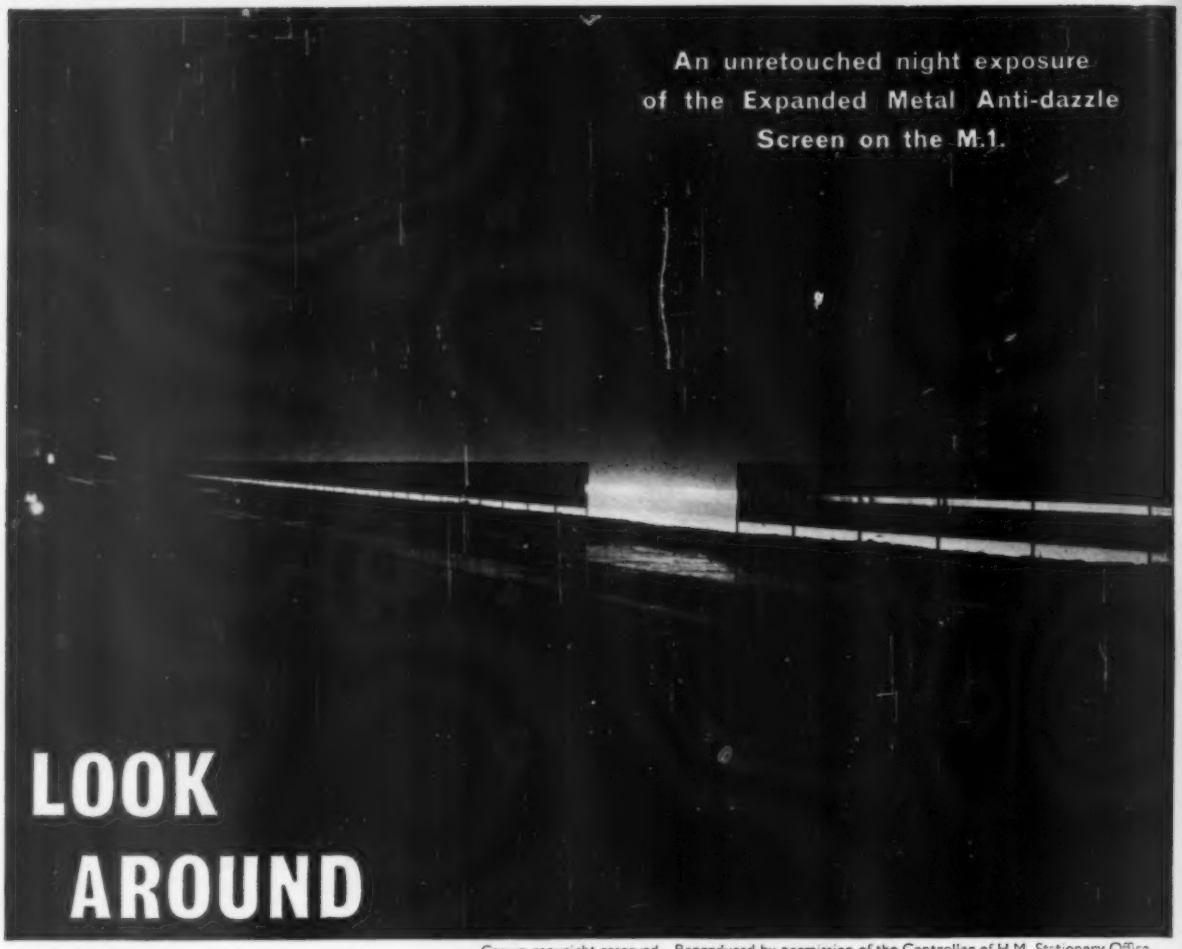
These signs are made with a plastic surface, print-impregnated with the words. This surface is virtually indestructable and completely weatherproof. The backing for the plastic is a form of Dural, which is non-rusting, light and very long wearing. The plastic is removable if it is required to change the legend, and new wordings are easily affixed with a specially treated adhesive.

T.E.C. 161 for further details

Proving the Scammell Sherpa
Hundreds of South African and Rhodesian motorists will soon benefit from the work of a small fleet of British-built dump trucks, exported there by the Leyland Motors Group. The vehicles are engaged in the construction of two linking tunnels, which will eliminate the only remaining bottleneck on the Great North Road and considerably ease the passage of cars and general transport between the Union and the Federation. Tunnelling alone will account for an estimated 90,000 cu. yd. of rock, and a further 120,000 cu. yd. will have to be cleared from surrounding areas to make way for approaches. Speed is an essential of the operation, and the rugged nature of the site demands vehicles built to withstand conditions on a round-the-clock basis.

The recently introduced Sherpa dumper is proving itself capable of matching these requirements. With its relatively low unladen weight, giving a high payload when running on the highway, it is of sufficiently robust construction to withstand rough treatment off the road. Set off to one side, the one-man all-steel cab has large areas of glass providing exceptional visibility to front, sides and rear.

T.E.C. 162 for further details



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The Powertruc Co. Ltd.
This company produces a mobile power source, enabling one engine to supply power to equipment as well as to the transmission of the vehicle. Known as the Powertruc, the vehicle consists basically of Ford Thames components, powered by the Ford 592E four-cylinder diesel engine, developing 62.5 b.h.p. at 2,250 r.p.m.

A main feature of the machine is the provision of direct drive, through a Metalistik disc coupling, to the equipment in use. As no gears are employed, no power loss is sustained, allowing the full capacity of the engine to be exploited. Further advantages claimed for the Powertruc are those of engine life and compactness—the former from the use of a single engine for both equipment and mobility, eliminating the need for cold starts several times a day, and the latter because the engine and the equipment to be driven is mounted on what is essentially a lightweight truck.

The engine, which can be forward-facing or rearward-facing, is mounted behind the cab on a full-length sub-frame which is fitted to cross-members above the rear springs. This arrangement distributes the weight of the engine and equipment over the springs and not on the basic frame of the vehicle. The sub-frame can be modified to suit the application for which it will be required.

A small generator within the cab is driven through an auxiliary clutch, and can be used for emergency or flood-lighting on site in conjunction with the equipment being powered. Auxiliary equipment can also be driven from this end of the engine through twin shafts which give a direct drive in either a clockwise or anti-clockwise rotation.

T.E.C. 163 for further details

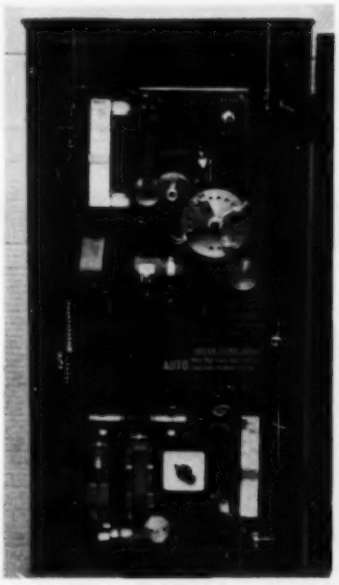
Portable Vehicle Actuated Signals
In nearly every case where temporary traffic signals are used to control one-way traffic at road obstructions, it is found that the predominant traffic flow reverses at least once a day. Where fixed time portable signals are used, adjustments to the timings had to be made to suit the varying traffic flow, but portable vehicle actuated signals are now available from The Forest City Electric Co. Ltd. The control is a motor driven mechanism, basically similar to a fixed time cycle unit which has been used for 30 years or more. It has been shown that the most suitable time setting for the green period is approximately proportional to traffic density. The controller acts so that in the absence of traffic the signals change on a fast time cycle with short green periods. Vehicles operating the respective detector during the green period will extend it and thus the duration of green will depend on the traffic density in the respective direction. The green may be extended up to a preset maximum time after which it must revert to green for the opposite direction. On failure of the detector unit the signals will continue to change to the minimum settings on that particular phase.

T.E.C. 164 for further details

Pluvex No. 1 sheeting being laid in position on one of the new bridges on the Maidenhead By-Pass.

Waterproofing of Bridges
Pluvex No. 1 bitumen sheeting—specially selected bitumens reinforced with closely woven, saturated hessian—has been used to waterproof five bridges over the Maidenhead By-Pass, at Windsor Road, Cannon Lane, Ascot Road, Shoppenhangers Lane and Monkey Island Lane. Pluvex sheeting, with hessian reinforcement, has the necessary tensile strength and flexibility to withstand the vibration caused by heavy and high-speed traffic. Applied in two layers bedded together with hot compound, it provides permanent protection from surface water, which may otherwise percolate through minor cracks in the concrete bridge-deck and attack the structural steelwork. Pluvex is made by The Rubberoid Co. Ltd.

T.E.C. 165 for further details



A view of the control unit of the portable vehicle actuated traffic signals made by The Forest City Electric Co. Ltd.

E. V. Twose (Manufacturing) Ltd.
This firm have recently introduced a new tractor-mounted mower/hedge-trimmer. This attachment, designed for use with eight different makes of tractor, is mounted in a position which gives completely unobstructed vision to the operator. Both the boom and the cutter bar are controlled hydraulically and the unit can be lowered to 6 in. below the mowing position or raised to give a height of 14 ft. One lever controls the angle of the boom and another the angle of the cutter bar. To avoid damage to the machine, provision is made for both cutter and boom to break back if any obstruction is met while working.

T.E.C. 166 for further details

H. A. Saunders, Ltd.
On their stand at the recent Public Works Exhibition, this firm showed, amongst other things, the Bristol PD 48 'Europa' tractor shovel. The specifications of the 'Europa' are:

Engine—Perkins P3/144 three-cylinder diesel developing 32 b.h.p. at 1,800 r.p.m.
Clutch—Borg and Beck 10 in. single dry plate clutch with ball thrust.
Gearbox—3 per cent nickel-chrome steel gears giving speeds of 1.5, 2.5, 5.0 m.p.h. and 2.0 m.p.h. in reverse.
Final drive—a pinion of 3 per cent nickel-chrome steel running on ball bearings. Gear wheel of similar material mounted on high duty cast-iron hub splined to axle shaft of 3 per cent nickel, oil hardened steel carried on ball bearings.

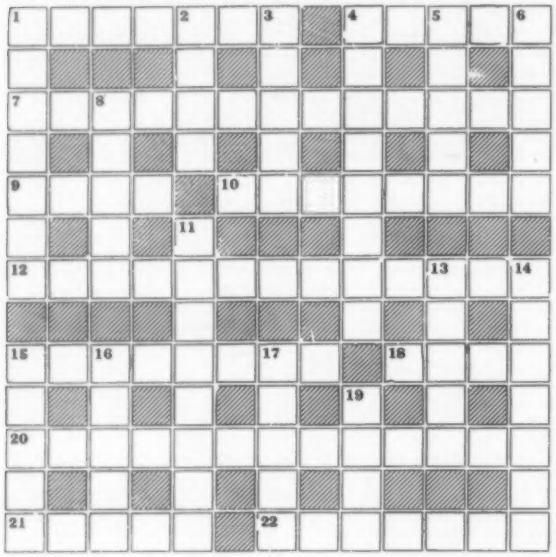
The shovel equipment is Shaeff pattern with a separate control for both boom and bucket movements. The bucket has a breakout force of 6,500 lb. through an arc of 150°, and replaceable digging teeth are fitted.

T.E.C. 167 for further details

Punched Tape Traffic Counter
An automatic traffic counter, which works on the punched tape system, is now available in this country. It records the passing of vehicles from various forms of sensing equipment—Sonar, pneumatic tube, photo-electric cell,

TRAFFIC ENGINEERING CROSSWORD NO. 8 by YEO

AMONG the clues and solutions will be found traffic engineering terms defined in the VOCABULARY OF TRAFFIC ENGINEERING TERMS published for *Traffic Engineering & Control* by Printerhall Ltd., and a copy of which is sent free to all subscribers to this journal. Copies are also available at 2s. 6d., post free, from the Circulation Manager, Traffic Engineering & Control, 34/40 Ludgate Hill, London, E.C.4.



SOLUTION TO CROSSWORD NO. 7

C	O	M	P	O	U	N	D	C	U	R	V	E
U	■	O	■	U	■	■	■	L	■	A	■	A
T	R	I	P	S	■	P	L	A	I	N	T	S
H	■	■	■	T	■	O	■	N	■	G	■	E
B	R	A	K	E	■	L	A	G	■	E	L	M
E	■	I	■	R	■	Y	■	■	■	■	■	E
R	■	D	I	S	T	A	N	C	E	S	■	N
T	■	■	■	■	■	N	■	A	■	O	■	T
S	A	M	■	P	A	D	■	B	A	S	I	C
D	■	A	■	E	■	R	■	T	■	■	■	U
U	N	C	H	A	R	Y	■	O	T	T	E	R
C	■	O	■	C	■	■	■	U	■	E	■	V
K	I	N	D	H	E	A	R	T	S	A	R	E

Across

1. Birthplace of Palladian architecture. (7)
4. Not a savory—just Indians on Horseback. (5)
7. With this one would not take a short sighted view of things. (13)
9. Hypocritical inclination. (4)
10 & 15. Time for a brake? (8 & 8)
12. E.W.N.
18. Is she in them making roads? (4)
20. Comprehensive representations in traffic engineering. (5 & 8)
21. Sticky siren? (5)
22. Not for commercial traffic. (7)

Down

1. Not necessarily a psychic medium. (7)
2. One of a copper is rarely loved. (4)
3. Ward off a green in France. (5)
4. Painting Zebra Crossings? (8)
5. Headgear on the Royal Institute near Naples. (5)
6. To scold. (5)
8. Puts one's shirts on boats. (8)
11. 'But, like a lackey, from the rise to set ------ -- the eye of Phoebus, and all night Sleeps in Elysium;' (Henry V). (6, 2)
13. A gentleman of Verona. (5)
14. It's common talk that the year has got in a muddle already. (7)
15. He throws a small cube. (5)
16. Won't go in organs. (5)
17. Cut price canary? (5)
19. Disturbed skills in the sky. (4)

INDUSTRIAL NEWS AND INFORMATION (*Concluded*)

trip or radar—and translates the data recorded into a form suitable for computor reading and analysis. This instrument, the FP traffic counter, is mainly mechanical in operation, although an electricaly operated pulse motor initiates the recording process. A six volt dry battery is sufficient power and is used in a portable model, while a permanent unit is available using rectified standard voltage.

The recording mechanism is started by an electrical contact which varies according to whatever sensing equipment is being used. Gears translate the movement of the pulse motor into a rotational drive to two coded discs, which have raised sections for punching the tape itself. The discs are marked and connected so that readings can be made direct. A clock driven cam powers the punching process and can be set to record totals at 15, 30 or 60 minute intervals. The maximum speed at which signals from the sensing equipment can be accepted is 25 per second, enough for the most crowded road.

Full ancillary equipment is available for handling the data obtained from the recording unit and a tape translator card puncher prepares the material for computor analysis, without any calculations on the part of the operators. The ancillary equipment and the traffic counter is manufactured by Fischer and Porter Co. of Pennsylvania.

T.E.C. 168 for further details

Please use the prepaid cards for the Reader Information Service. For further details of items mentioned in this journal, complete and return the card to us.

Corrected Information

The information contained in the December issue of *Traffic Engineering & Control* on the subject of a proposed garage to be constructed by Pigeon Hole Parking Ltd. in Leeds was unfortunately incorrect. The garage in question is in fact to be built in Liverpool, where parking space for more than 200 cars is to be provided. This error is very much regretted.

T.E.C. 169 for further details

Standard Bridge Railing

Owing to the exceptionally large number of enquiries for information on the bridge railing which has been accepted as standard by the Department of Highways, Ontario, Canada, we have decided to publish the name and addres of the manufacturer in full. They are: Acrow (Engineers) Ltd., South Wharf, London, W.2.